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**Nakamura et al.**

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(54) **CUTTING APPARATUS, DISPLAY CONTROL DEVICE, AND NON-TRANSITORY COMPUTER READABLE STORING MEDIUM**

(58) **Field of Classification Search**  
CPC ..... B26D 5/005; B26D 5/007; B26F 1/3806; G06F 8/34; G06F 3/0481; G05B 19/0426  
See application file for complete search history.

(71) Applicant: **BROTHER KOGYO KABUSHIKI KAISHA**, Nagoya-shi, Aichi-ken (JP)

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(72) Inventors: **Yoshinori Nakamura**, Toyohashi (JP); **Manami Ota**, Nagoya (JP); **Kentaro Sugiyama**, Gifu (JP); **Hideaki Nagasaka**, Nagoya (JP)

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(73) Assignee: **BROTHER KOGYO KABUSHIKI KAISHA**, Nagoya-Shi, Aichi-Ken (JP)

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(21) Appl. No.: **14/868,860**

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*Primary Examiner* — Nicholas Augustine

(74) *Attorney, Agent, or Firm* — K&L Gates LLP

(30) **Foreign Application Priority Data**

Sep. 30, 2014 (JP) ..... 2014-199964

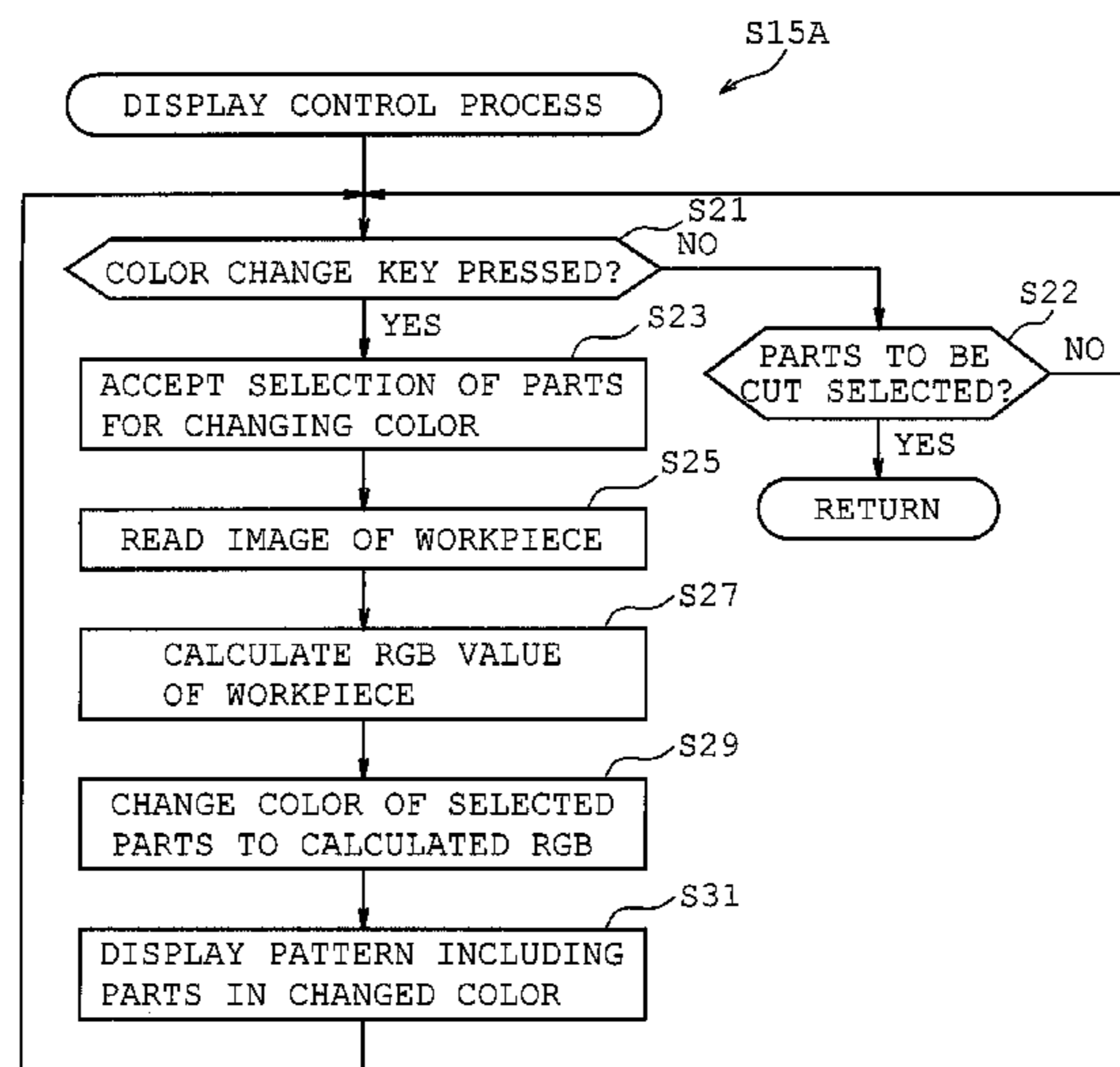
(57) **ABSTRACT**

(51) **Int. Cl.**  
**G06F 3/048** (2013.01)  
**B26D 5/00** (2006.01)  
**B26F 1/38** (2006.01)  
**G06F 3/01** (2006.01)

A cutting apparatus includes a storing unit configured to store data of a pattern having plural parts of different colors or designs; a display unit; and a control device. The control device is configured to: acquire data of a color or a design of at least one workpiece; change a color or a design of at least one part of a pattern in the data stored in the storing unit to the color or the design acquired for the at least one workpiece; and display the pattern having the at least one part in which the color or the design has been changed on the display unit.

(52) **U.S. Cl.**  
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**19 Claims, 18 Drawing Sheets**



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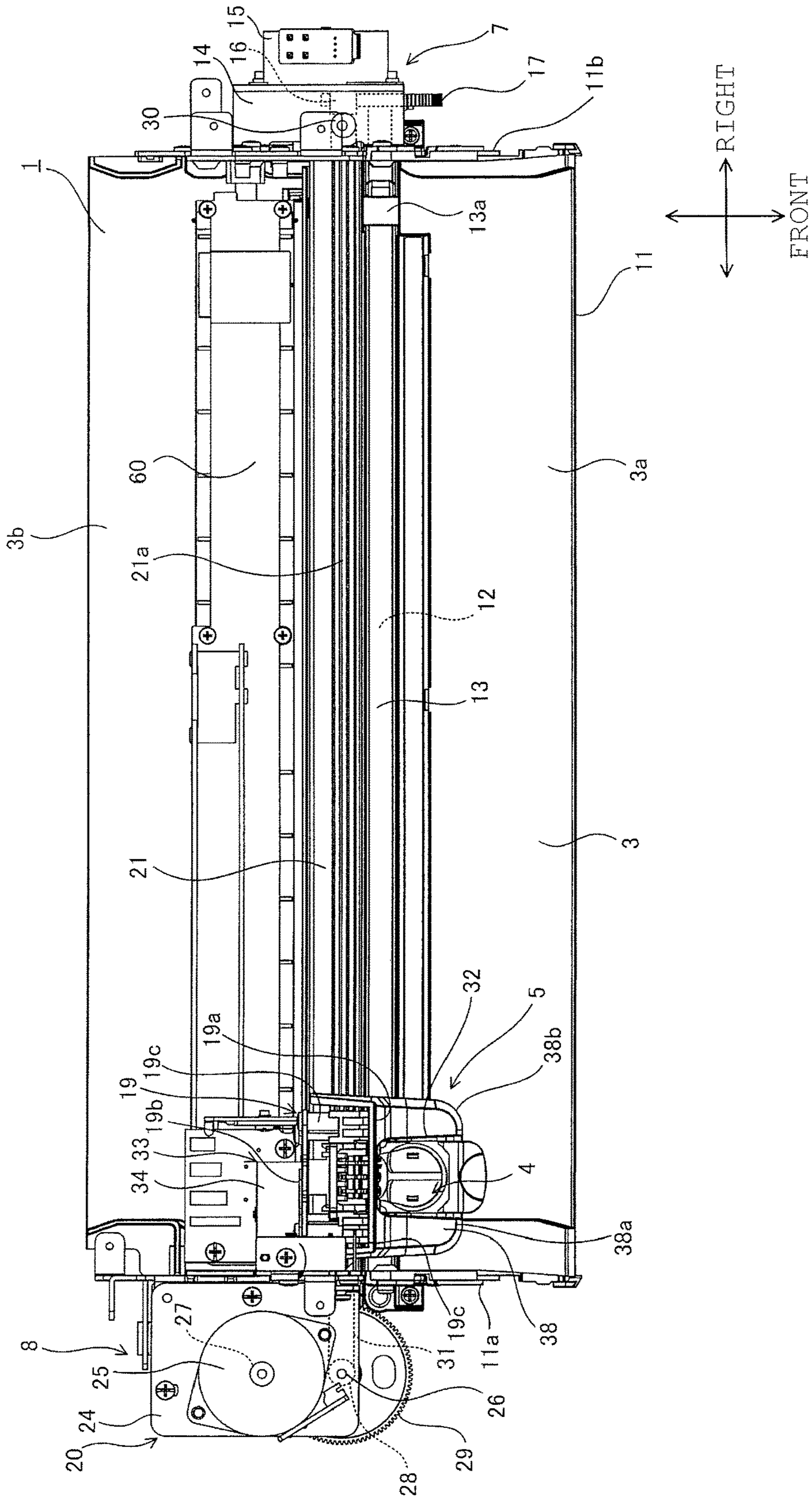


FIG. 2

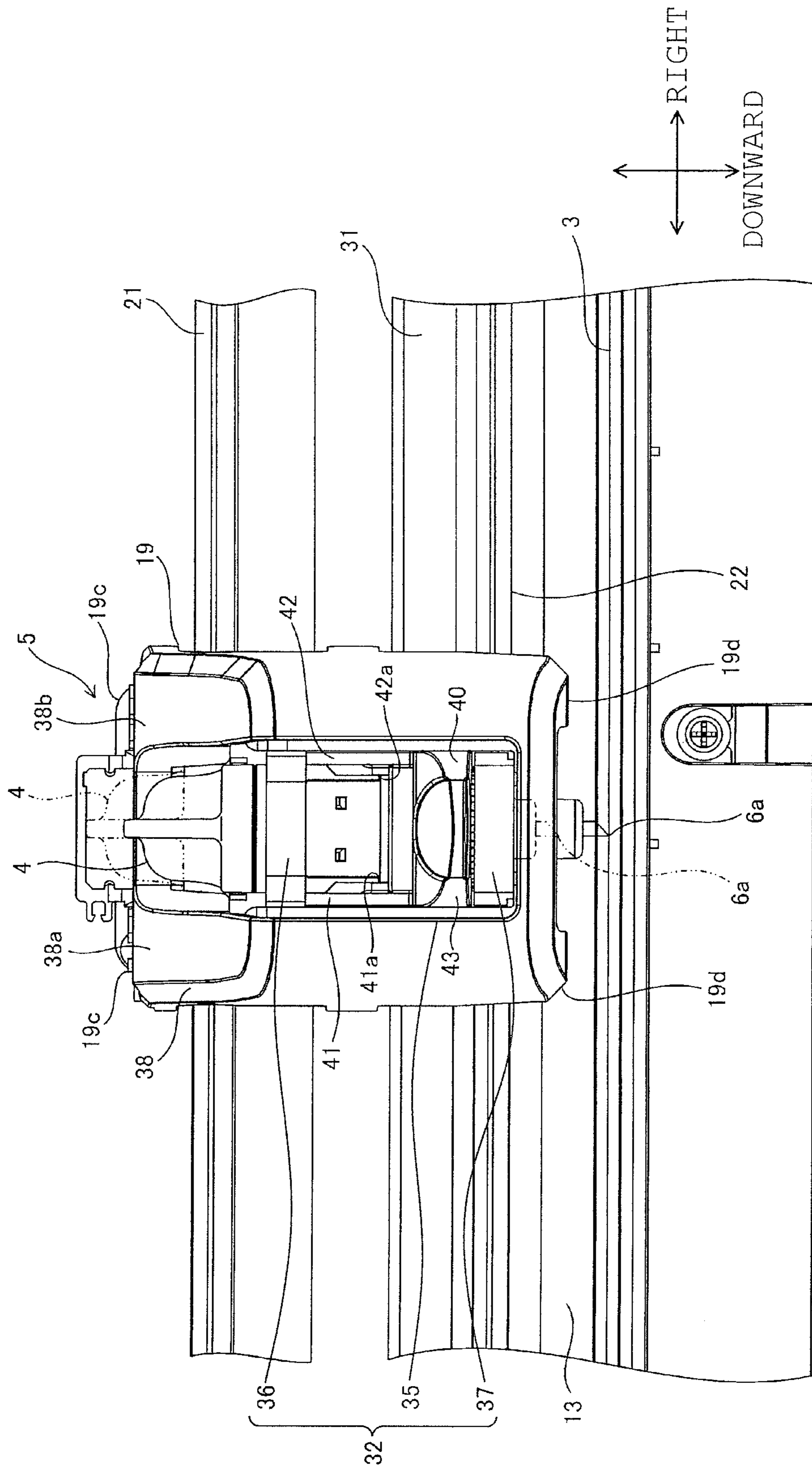


FIG. 3

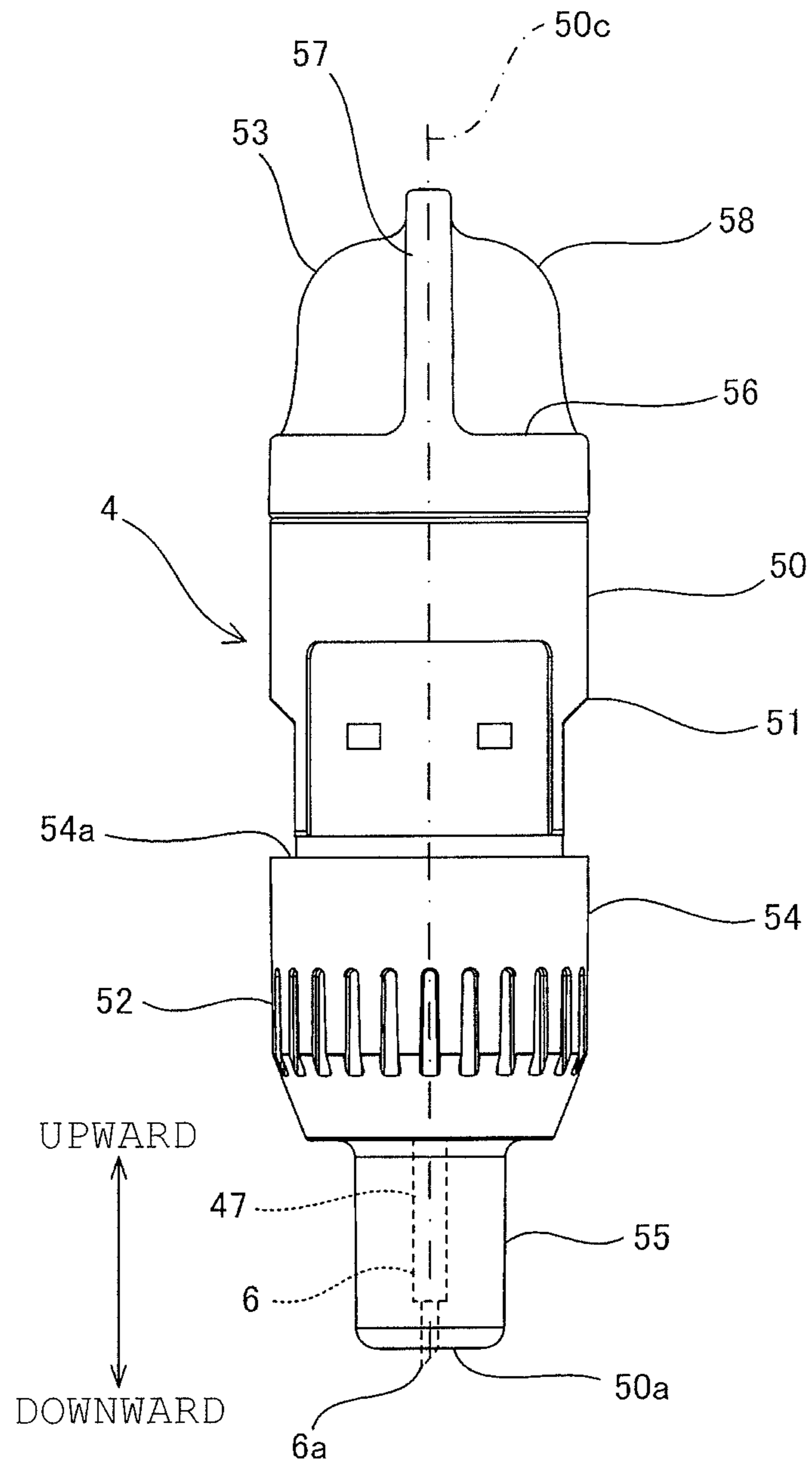


FIG. 4

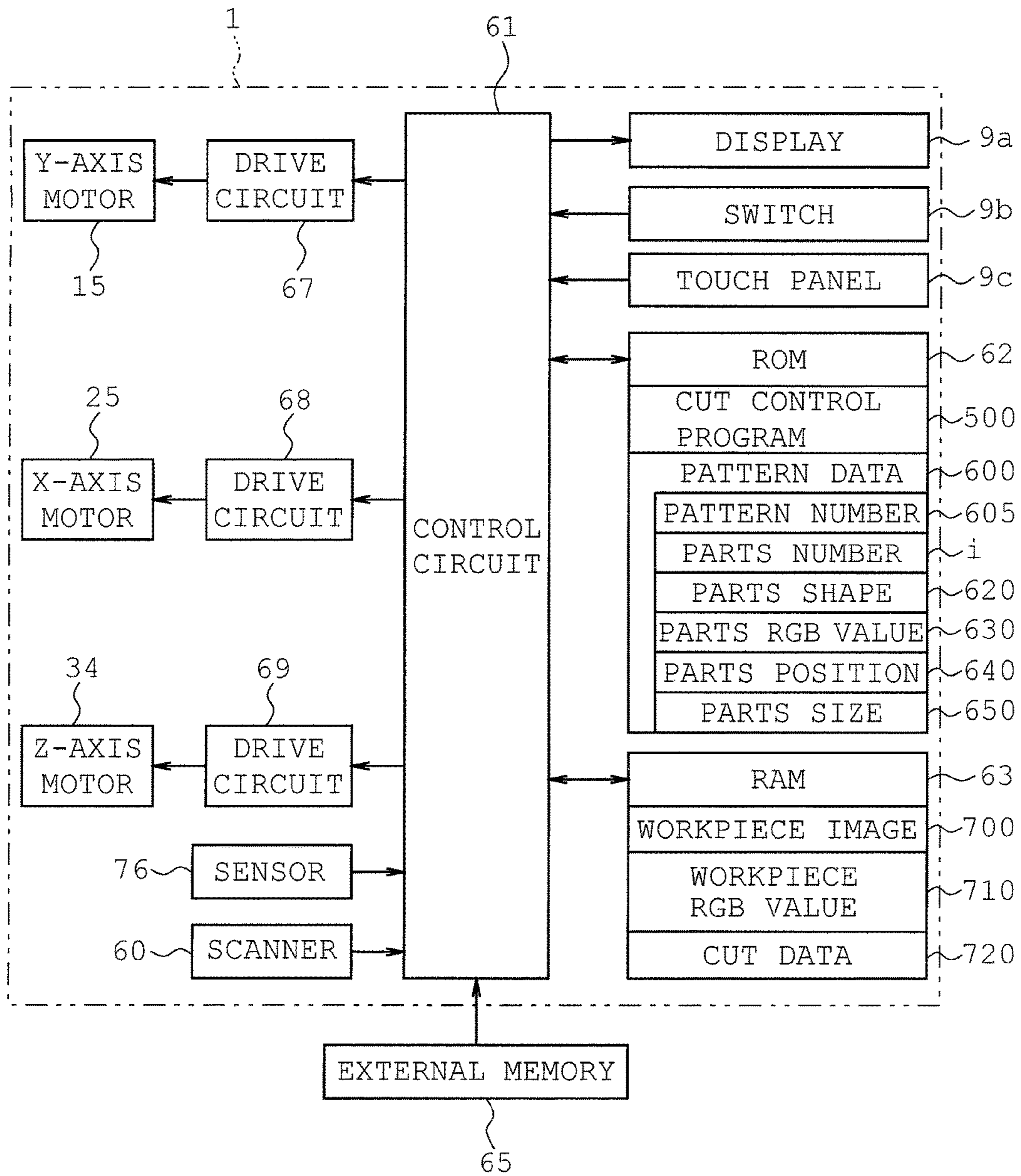


FIG. 5

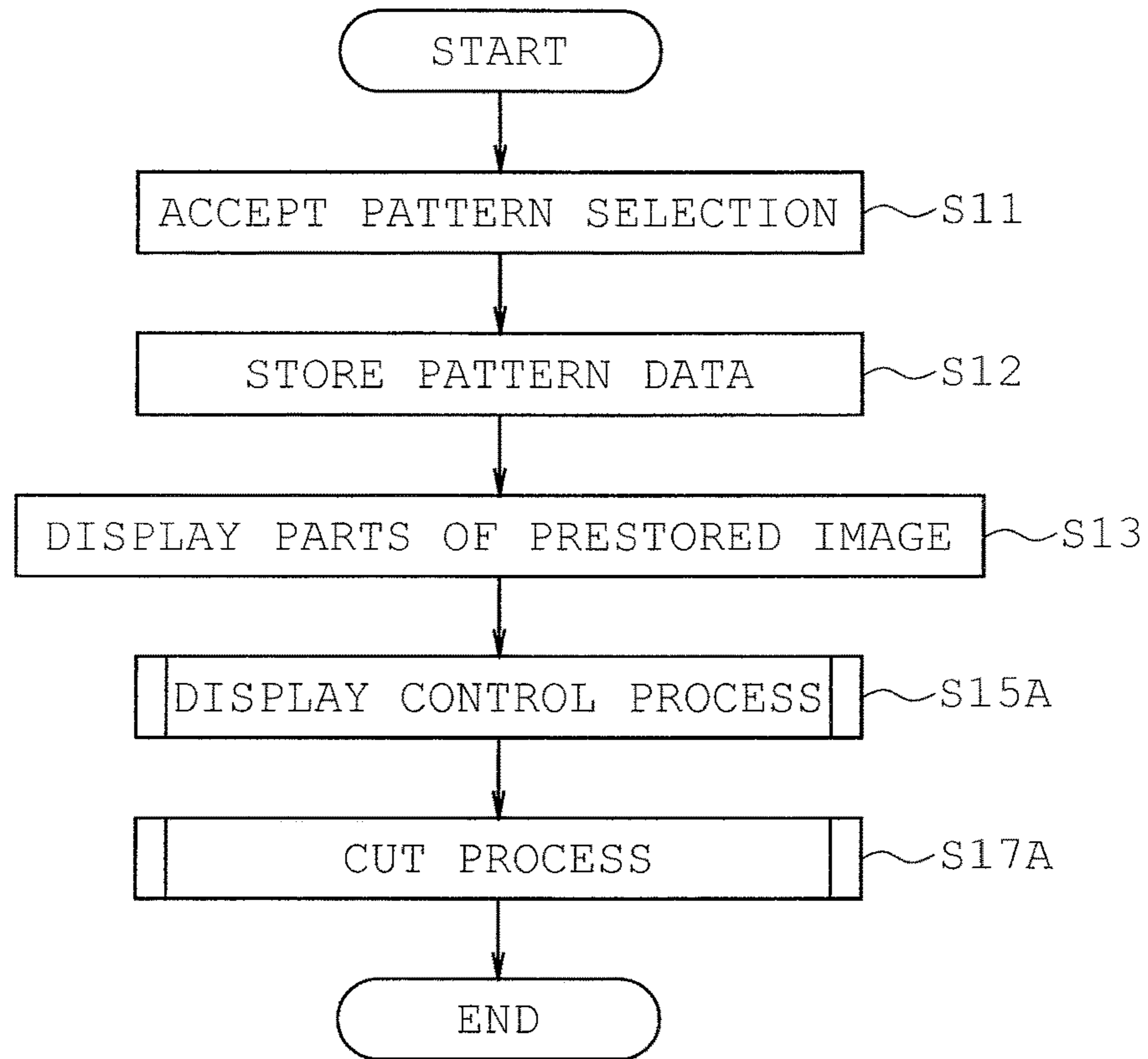


FIG. 6



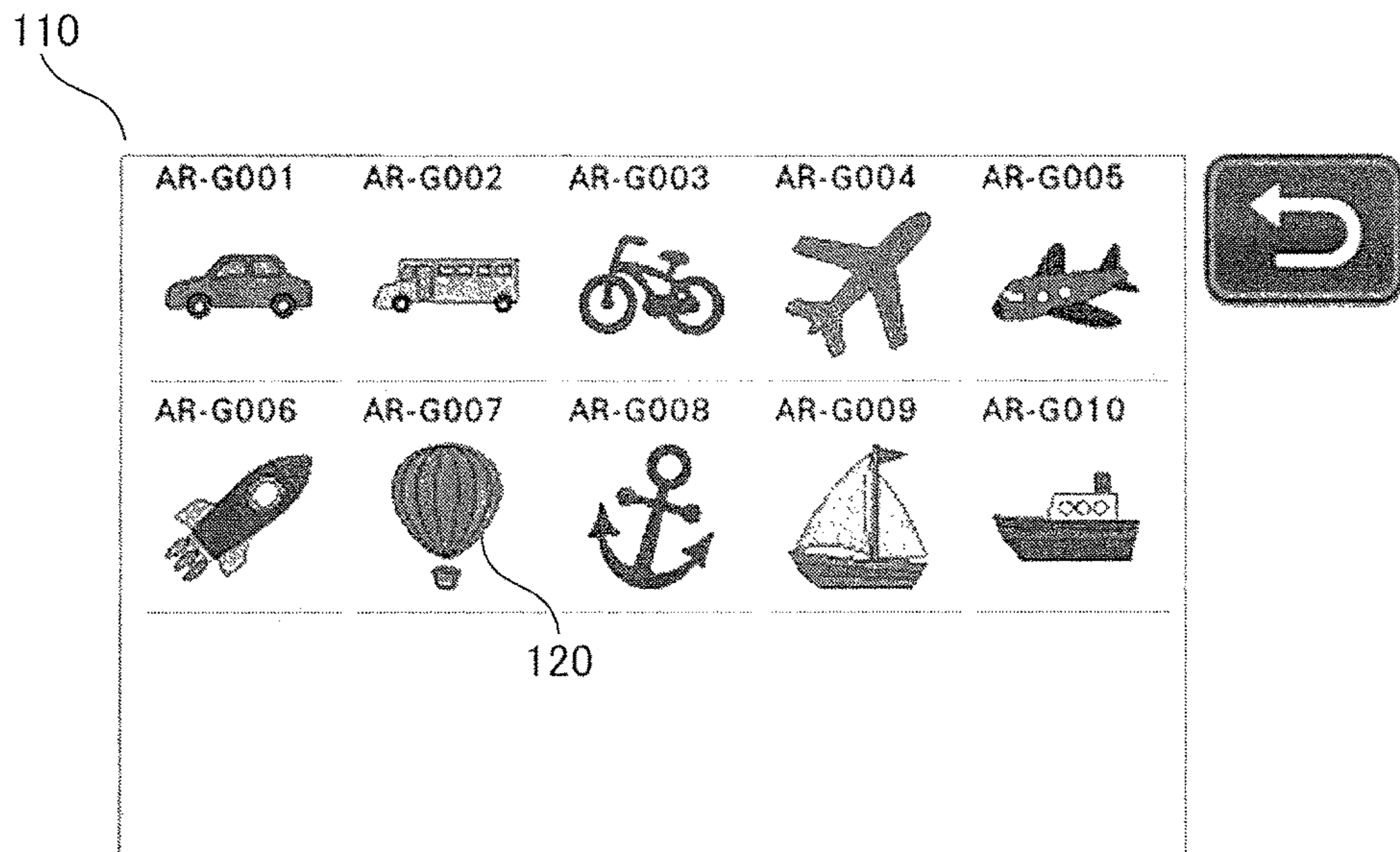


FIG. 7

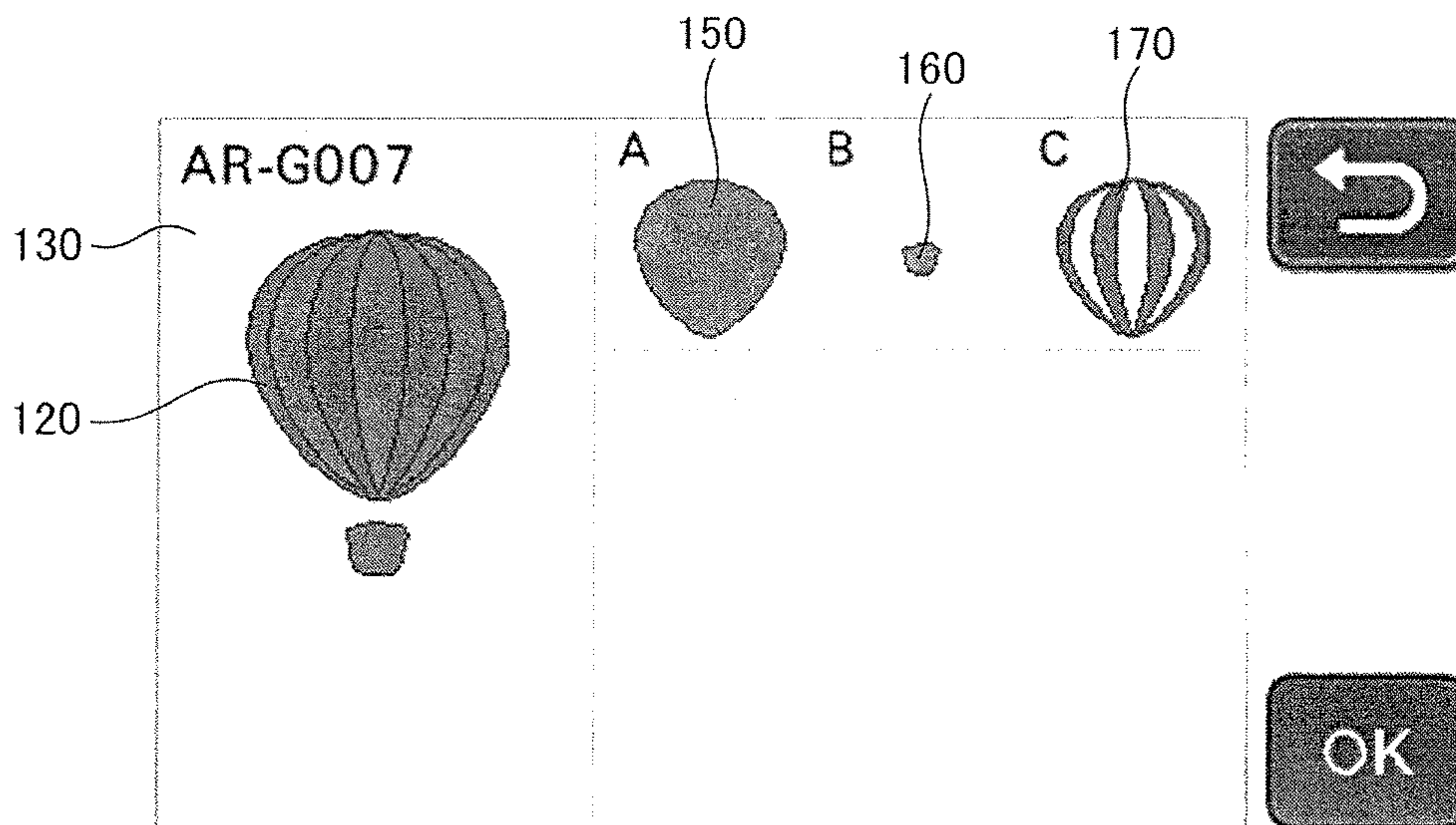


FIG. 8

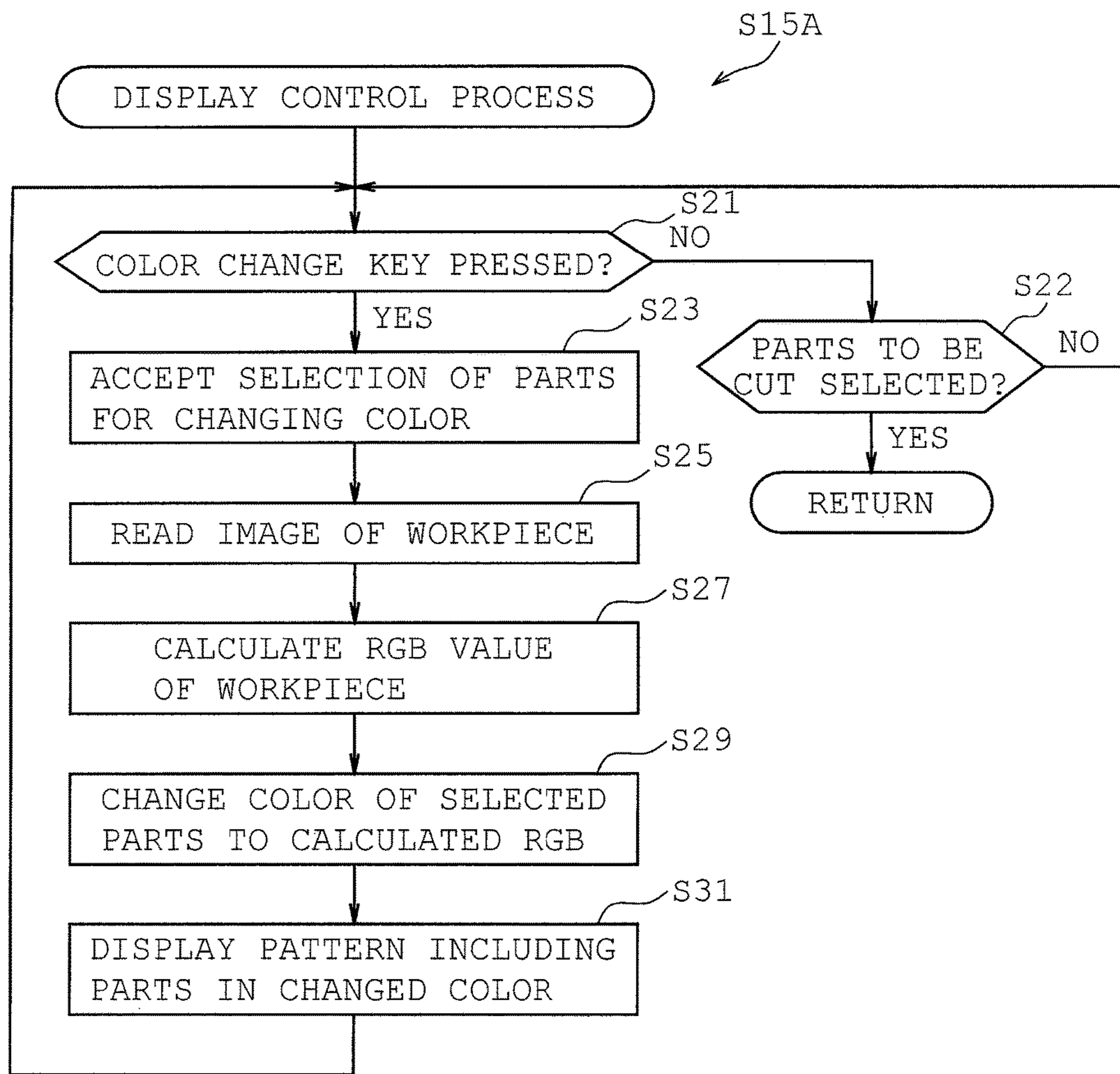


FIG. 9

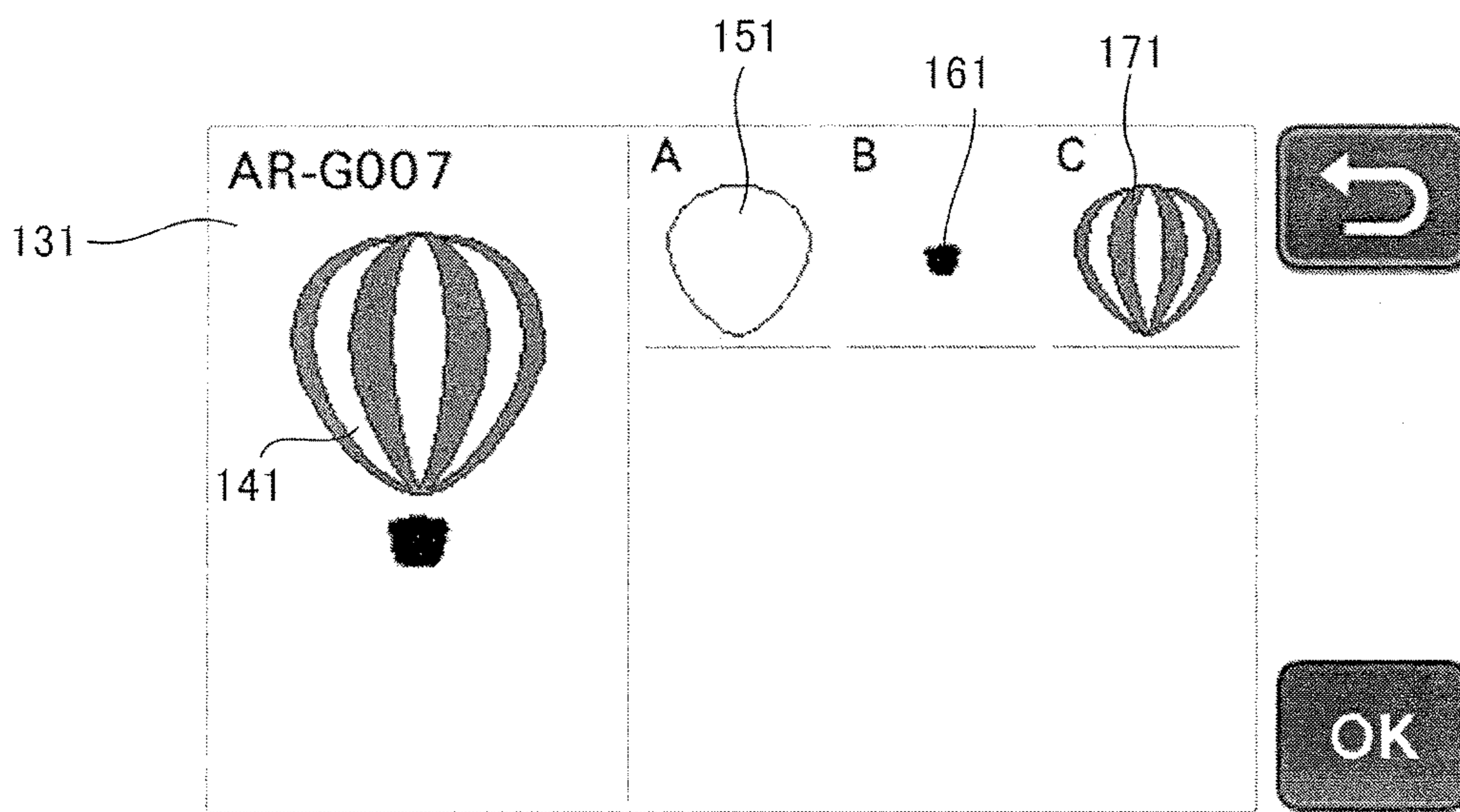


FIG. 10

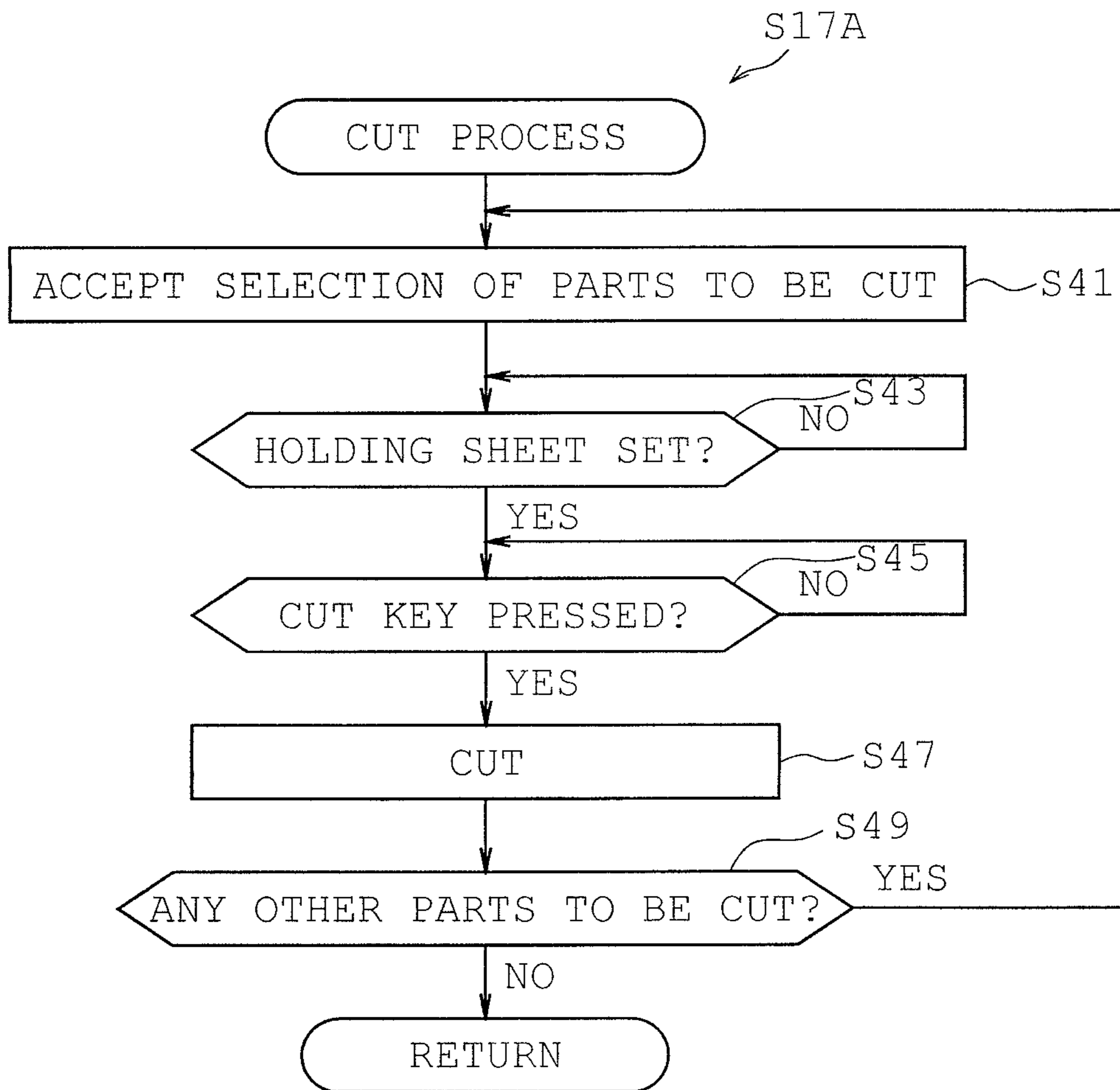


FIG. 11

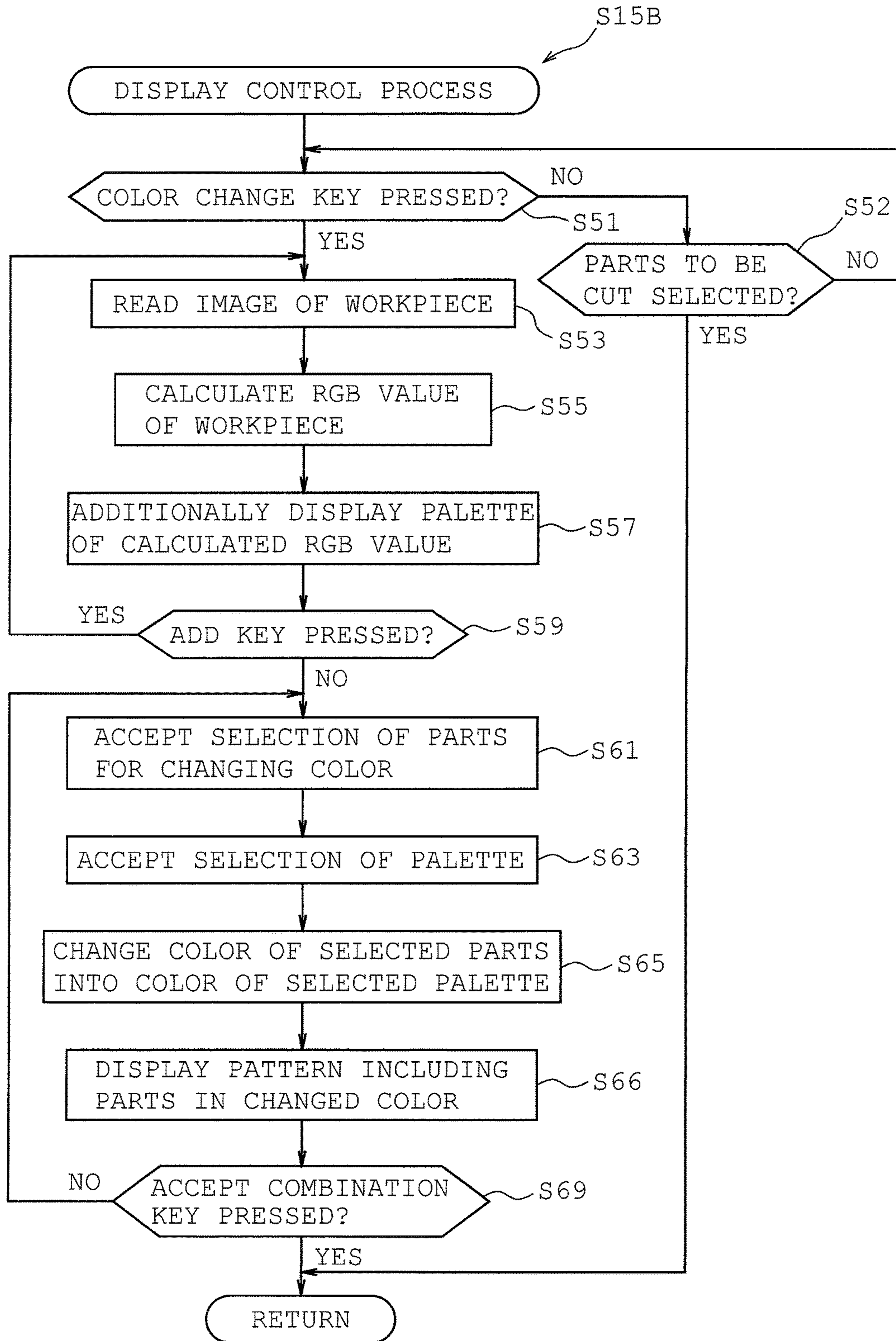


FIG. 12

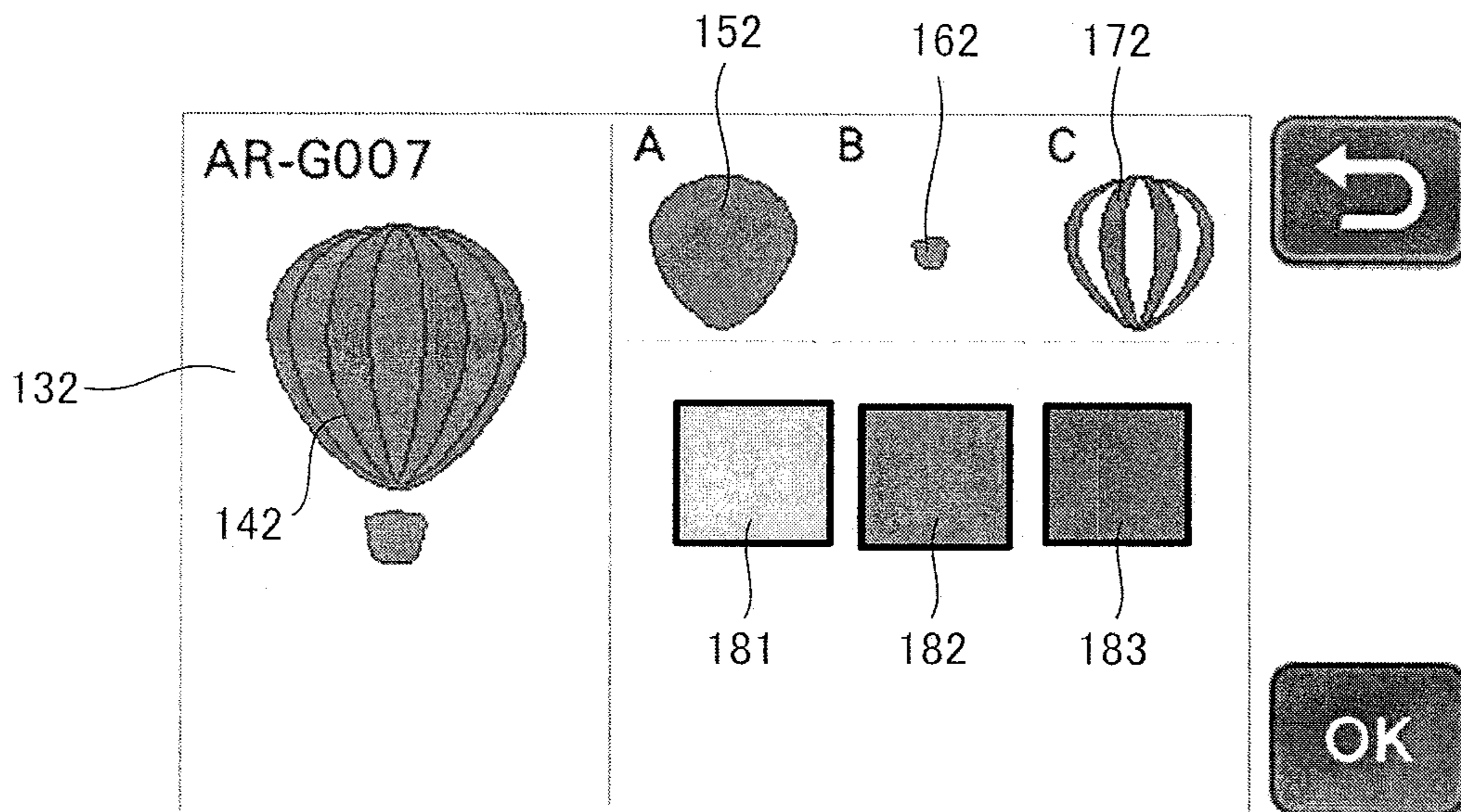


FIG. 13

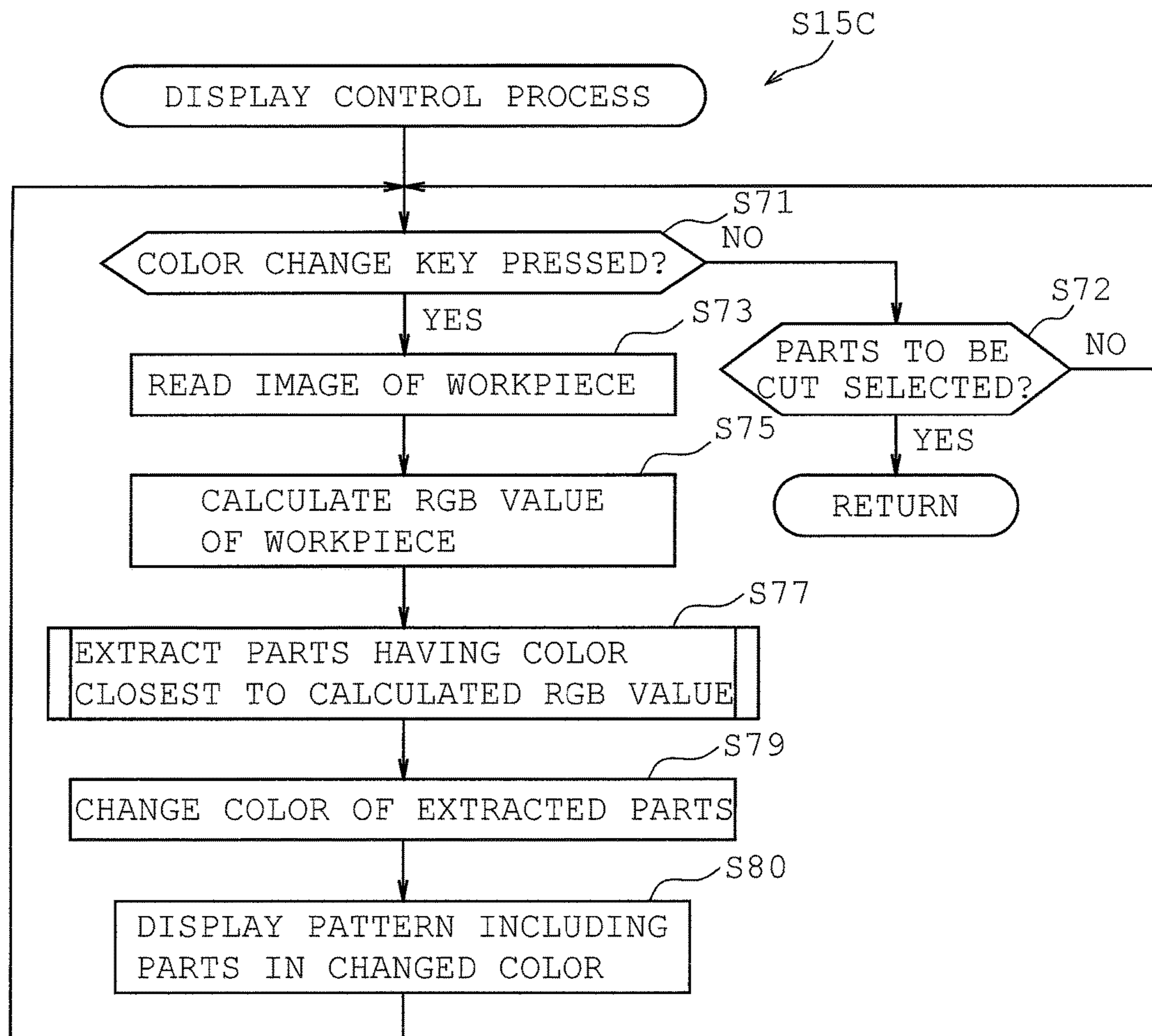


FIG. 14

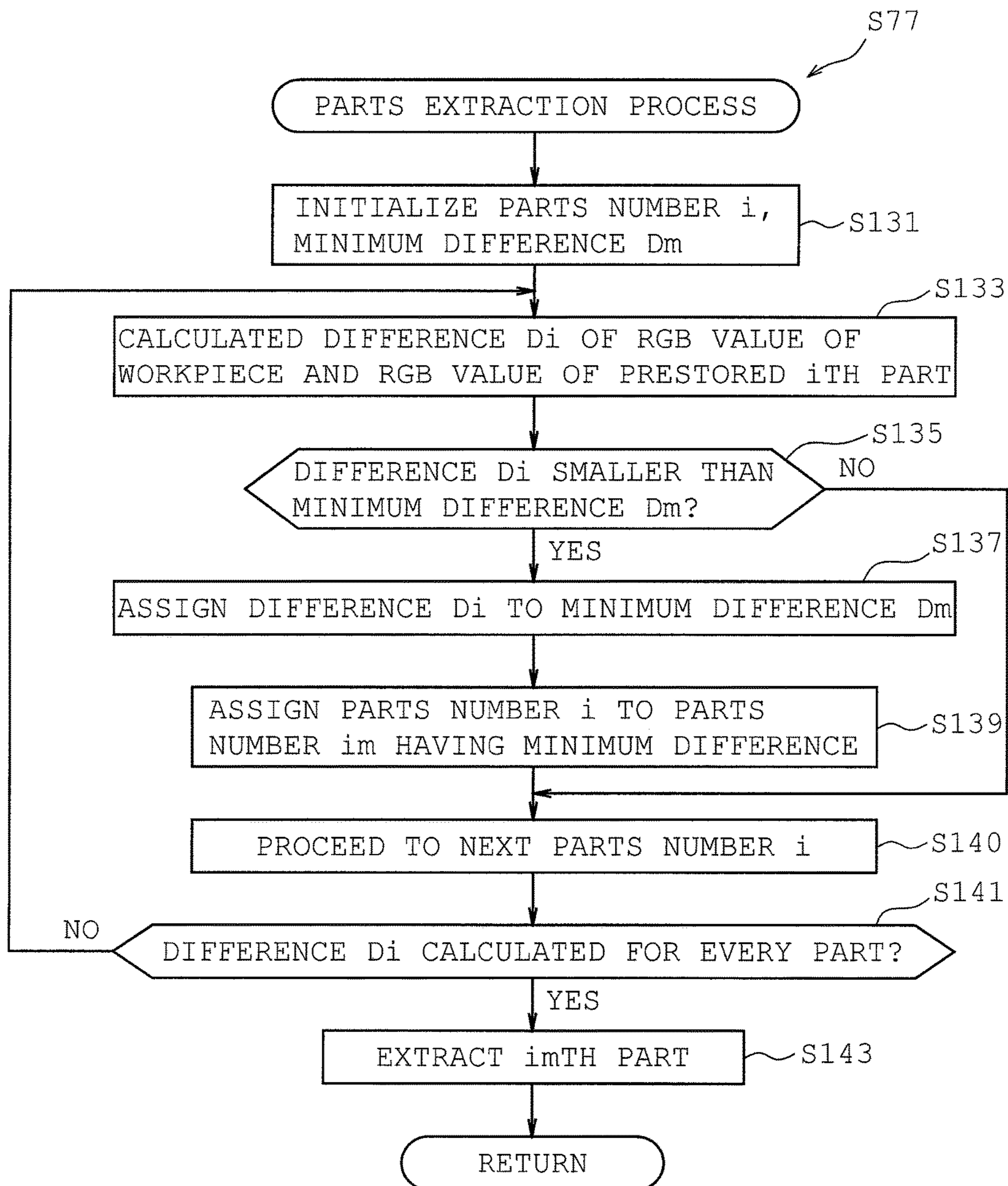


FIG. 15



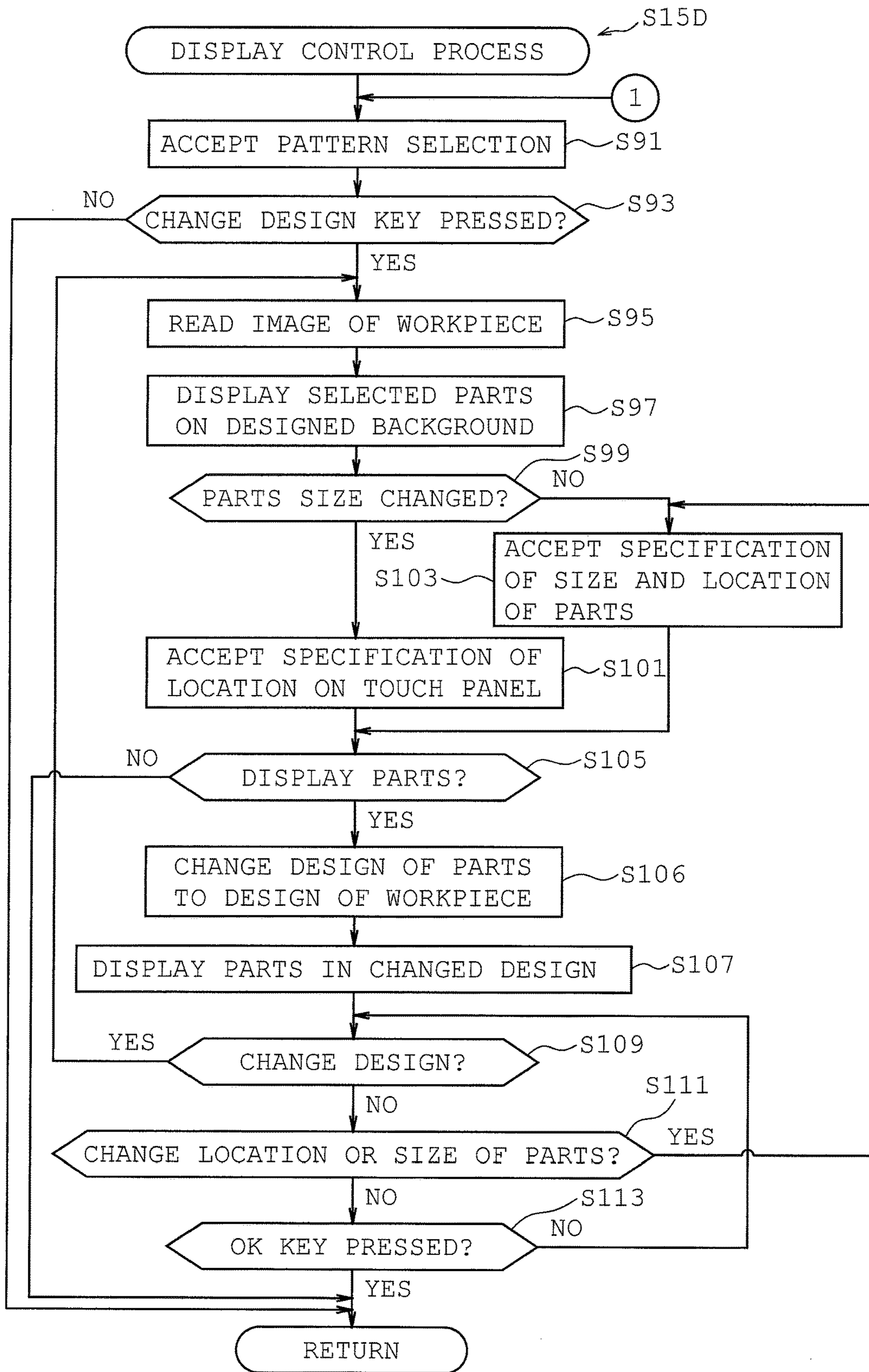


FIG. 16

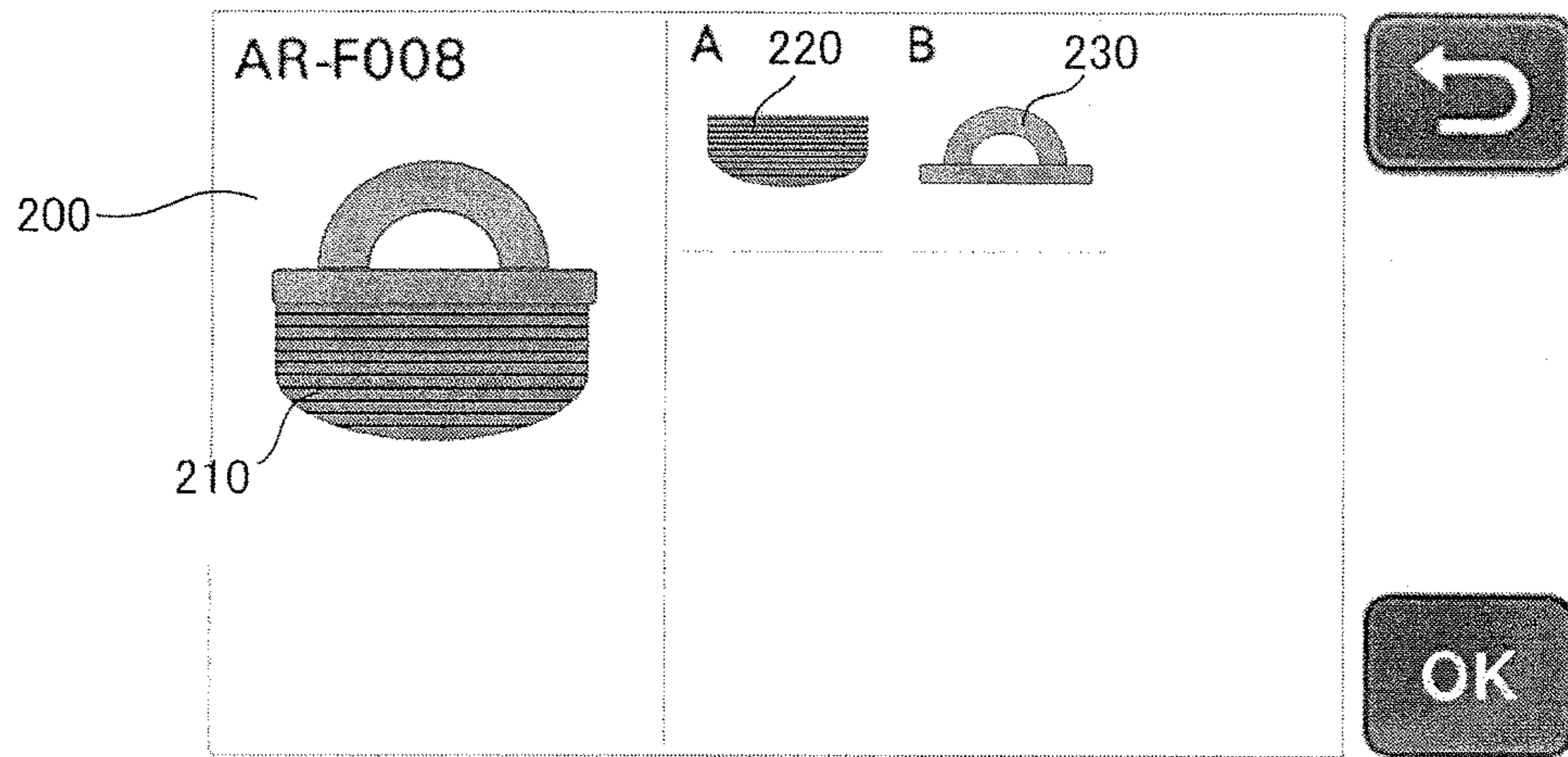


FIG. 17

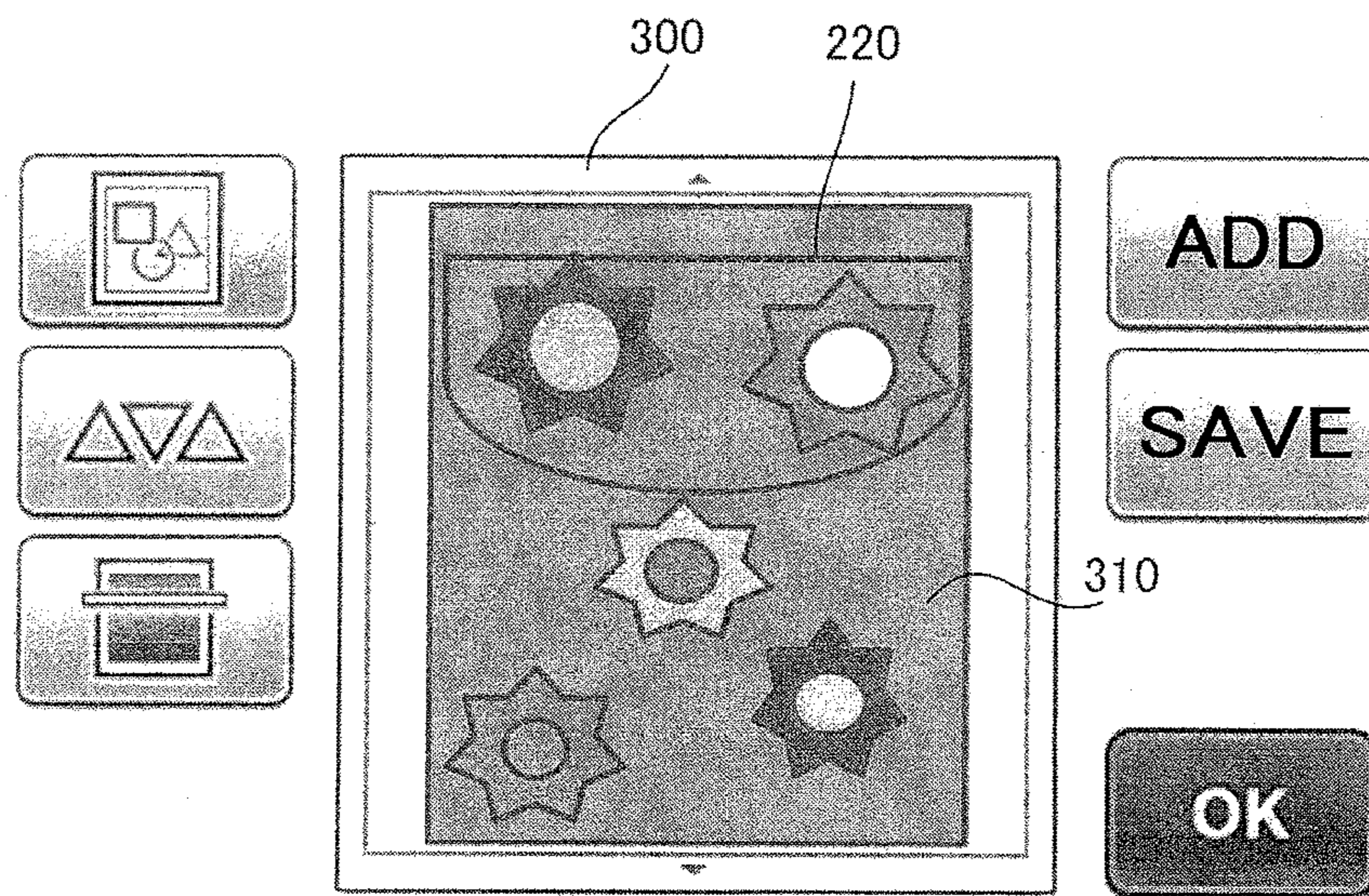


FIG. 18

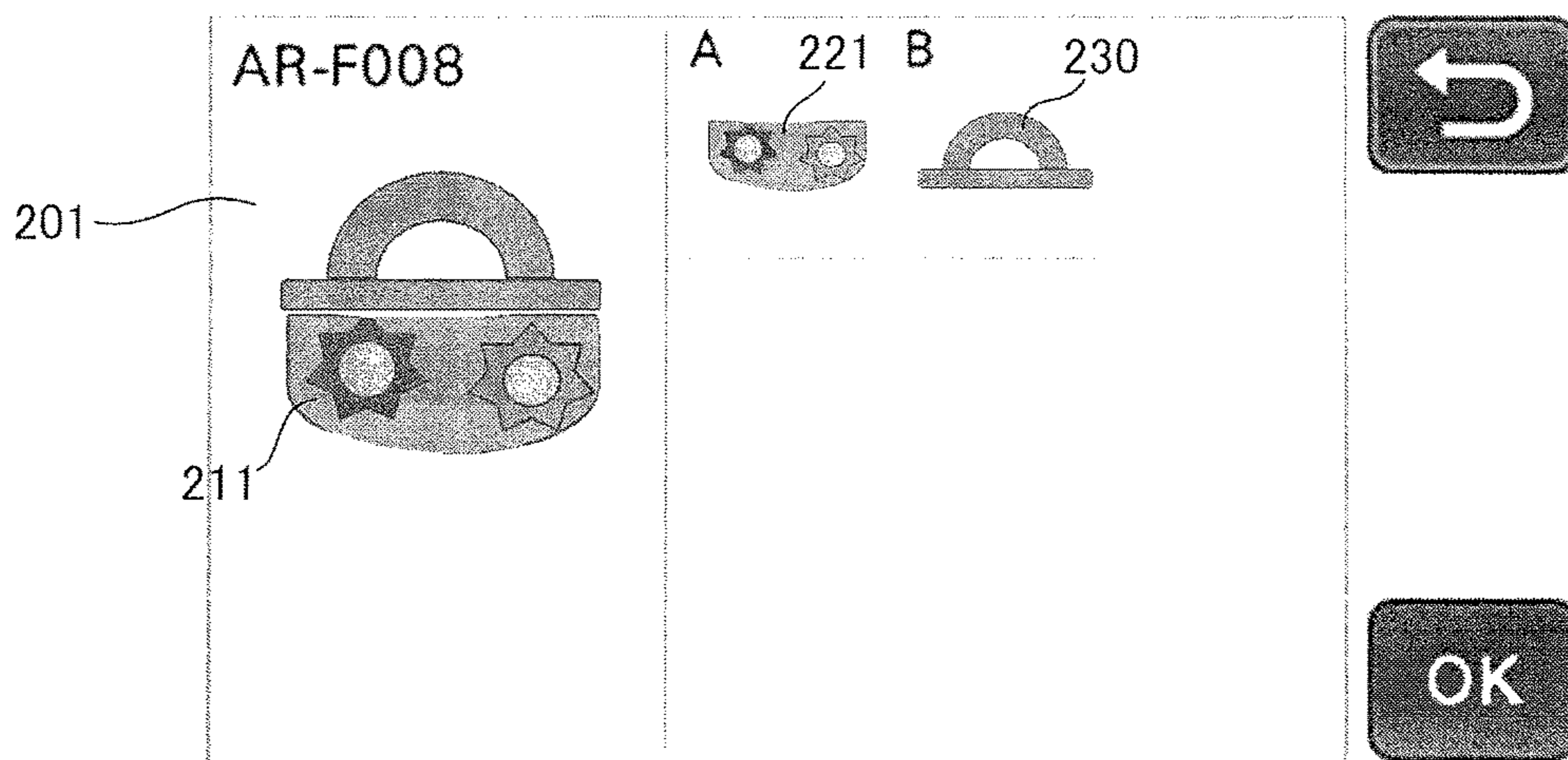


FIG. 19

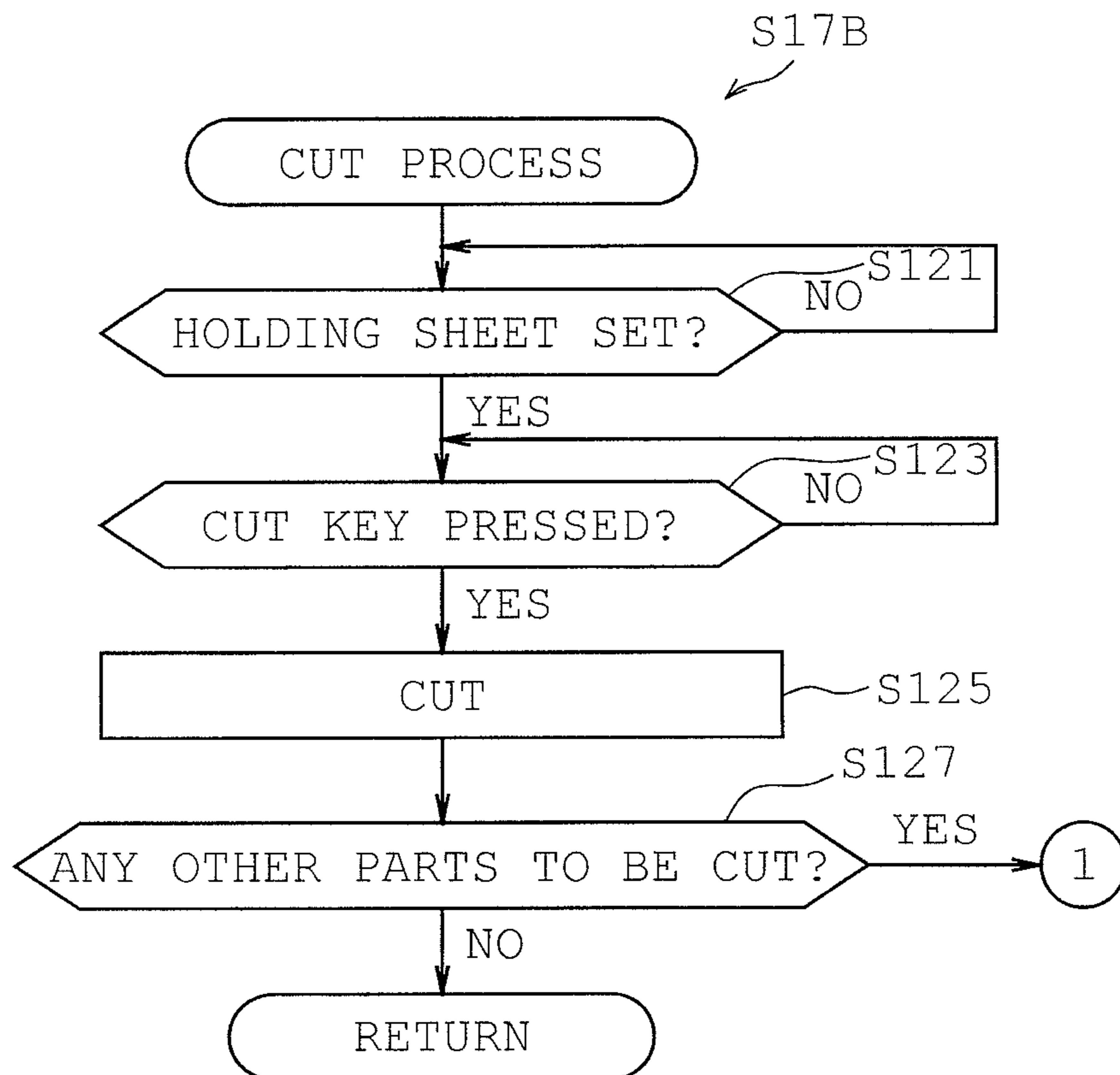


FIG. 20

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**CUTTING APPARATUS, DISPLAY CONTROL  
DEVICE, AND NON-TRANSITORY  
COMPUTER READABLE STORING  
MEDIUM**

CROSS-REFERENCE TO RELATED  
APPLICATION

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application 2014-199964, filed on, Sep. 30, 2014, the entire contents of which are incorporated herein by reference.

## FIELD

The disclosure relates to a cutting apparatus, a display control device, and a non-transitory computer readable storing medium.

## BACKGROUND

Conventionally, there has been provided an automatic cutting apparatus configured to capture an image of a single workpiece placed on a table and matching the design of the workpiece to each of the multiple parts of a pattern. The automatic cutting apparatus is provided with a video camera for example and a monitor. The video camera captures a video of a single cloth placed on a cutting table. The monitor displays the video of the cloth and each of the parts of a pattern. The user is to rotate or move each of the parts to match the design of the cloth. Thus, the user is allowed to layout each of the parts to appropriate locations on the cloth.

The above described cutting apparatus is capable of match multiple parts to a single cloth shot by a video camera. However, it is not possible to change the different colors or designs of each of the multiple parts to match the different colors or designs of multiple cloths. Thus, it is not possible to display a single pattern in which colors or the designs of the multiple parts are changed to the different colors or the design of the multiple cloths. It has thus, been difficult for the user to know the accurate combination of colors and the designs of multiple parts before the cutting operation.

## SUMMARY

Aspects described herein provide a cutting apparatus, a display control device, and a non-transitory computer readable storing medium capable of displaying multiple parts changed to the colors and the designs of multiple workpieces before a workpiece is cut.

According to aspects of the disclosure, a cutting apparatus includes a storing unit configured to store data of a pattern having plural parts of different colors or designs; a display unit; and a control device. The control device is configured to: acquire data of a color or a design of at least one workpiece; change a color or a design of at least one part of a pattern in the data stored in the storing unit to the color or the design acquired for the at least one workpiece; and display the pattern having the at least one part in which the color or the design has been changed on the display unit.

## BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the disclosure are illustrated by way of example, and not by limitation, in the accompanying figures in which like reference characters may indicate similar elements.

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FIG. 1 is a perspective view illustrating the internal structure of a cutting apparatus 1 with a body 2 of the cutting apparatus 1.

FIG. 2 is a plan view illustrating the internal structure of the cutting apparatus 1.

FIG. 3 is a front view illustrating the vicinity of a cut head 5.

FIG. 4 is a front view of a cartridge 4.

FIG. 5 is a block diagram schematically indicating an electrical configuration of the cutting apparatus 1.

FIG. 6 is a flowchart indicating a cut control process 500.

FIG. 7 illustrates a pattern selection screen 110.

FIG. 8 illustrates a parts screen 130.

FIG. 9 is a flowchart indicating a process flow of a display control program of step S15A.

FIG. 10 illustrates a parts screen 131.

FIG. 11 is a flowchart indicating a process flow of a cut process of step S17A.

FIG. 12 is a flowchart indicating a process flow of the display control program of step S15B.

FIG. 13 is a parts screen 132 containing palettes 181, 182, and 183.

FIG. 14 is a flowchart indicating a process flow of the display control program of step S15C.

FIG. 15 is a flowchart indicating a process flow of a parts extraction process of step S77.

FIG. 16 is a flowchart indicating a process flow of the display control program of step S15D.

FIG. 17 illustrates a parts screen 200.

FIG. 18 illustrates a parts locationing screen 300.

FIG. 19 illustrates a parts screen 201 in which designs have been changed.

FIG. 20 is a flow chart indicating a process flow of the cut process of step S17B.

## DETAILED DESCRIPTION

For a more complete understanding of the present disclosure, needs satisfied thereby, and the objects, features, and advantages thereof, reference now is made to the following descriptions taken in connection with the accompanying drawings. Hereinafter, illustrative embodiments will be described with reference to the accompanying drawings. [Structure of Cutting Apparatus 1]

Referring to FIG. 1, a description will be given on the structure of the cutting apparatus 1 of the present embodiment. The cutting apparatus 1 is configured to cut a workpiece 101. The cutting apparatus 1 is provided with a body 2, a platen 3, a machine frame 11, a cut head 5, a feed mechanism 7, a transfer mechanism 8, a display 9a, and switches 9b.

The feed mechanism 7 is configured to feed a holding sheet 10 set on the platen 3 in a predetermined feed direction. The transfer mechanism 8 transfers the cut head 5 in a direction crossing the direction in which the holding sheet 10 is fed. For example, the cut head 5 may be transferred in a direction orthogonal to the direction in which the holding sheet 10 is fed. In the present embodiment, forward and rearward direction in which the feed mechanism 7 is fed is defined as the Y direction. The left and right direction in which the transfer mechanism 8 is transferred is defined as the X direction. The up and down direction orthogonal to the front and rear direction and the left and right direction is defined as the Z direction. The feed mechanism 7 and the transfer mechanism 8 serve as a transfer unit 20 configured to relatively transfer the holding sheet 10 holding the workpiece 101 and the cut head 5 in the

X and Y directions. That is, the transfer unit **20** is configured to be capable of moving a cutting blade **6** and the workpiece **101** so that the cutting blade **6** cuts parts of patterns from the workpiece **101**.

The body **2** is shaped like a laterally elongate rectangular box. A front opening **2a** is formed into the front face of the body **2**. A front cover **2b** configured to open and close the front opening **2a** is provided at the front face of the body **2**. The holding sheet **10** holding the workpiece **101** is set on the platen **3** by the user with the front opening **2a** opened. A later described cartridge **4** may be detachably attached to a cartridge holder **32** of the cut head **5** by the user.

The machine frame **11** is attached to the body **2**. The machine frame **11** is provided with sidewalls **11a** and **11b**. The sidewalls **11a** and **11b** are located on the left and right sides of the platen **3**.

The display **9a** is provided on the right side portion of the upper surface of the body **2**. The display **9a** is a liquid crystal color display capable of displaying in full color. Switches **9b** allowing user operation are provided around the display **9a**. A touch panel **9c** is provided on the surface of the display **9a**. The display **9a** presents information pertaining to pattern cutting such as images of various patterns and messages, etc. that need to be informed to the user. The user is allowed to select a pattern and parts of patterns from the choice of patterns and parts presented on the display **9a**, select various processing modes, set various parameters, and make various inputs by operating the switches **9b** and the touch panel **9c**.

When the workpiece **101** is being cut by the cutting apparatus **1**, the platen **3** is located under the holding sheet **10**. The upper surface portion of the platen **3** includes a horizontal surface. The holding sheet **10** holding the workpiece **101** is fed over the platen **3**.

The holding sheet is made of a synthetic resin material for example and is shaped like a rectangular sheet. The holding sheet **10** is configured to hold the workpiece **101**. An adhesive layer **10v** is formed on area of the upper surface of the holding sheet **10** surrounded by edge portions **10a**, **10b**, **10c**, and **10d**. The adhesive layer **10v** is formed for example by applying an adhesive coating on the holding sheet **10**. The holding sheet **10** is configured to hold the workpiece **101** by allowing the workpiece **101** to stick on the adhesive layer **10v**. The adhesive force of the adhesive layer **10v** is controlled to a level that reliably holds the workpiece **101** unremovably during the cutting operation by a cutting blade **6** of the cartridge **4** while allowing the workpiece **101** to peel relatively easily after the cutting operation has been completed. The size of the workpiece **101** is substantially the same as the size of the region in which the adhesive layer **10v** is formed. The size of the region which may be cut by the cutting apparatus **1** is substantially the same as the size of the workpiece **101**. Further, examples of workpiece **101** include materials such as paper and cloth.

[Explanation of Feed Mechanism **7**]

The feed mechanism **7** is explained in detail hereinafter with reference to FIGS. **1** and **2**. The feed mechanism **7** is provided with a drive roller **12**, a pinch roller **13**, a mount frame **14**, a Y-axis motor **15**, a drive gear, and a follower gear **17**.

The drive roller **12** and the pinch roller **13** are disposed between the left and right sidewalls **11a** and **11b**. The drive roller **12** and the pinch roller **13** extend in the left and right direction. The pinch roller **13** and the drive roller **12** are disposed one over the other in the up and down direction. In this example, the pinch roller **13** is disposed above the drive roller **12**.

The left and right end sides of the drive roller **12** are supported rotatably by the sidewalls **11a** and **11b**. A follower gear **17** is provided on the right end of the drive roller **12**. The mount frame **14** is attached to the outer surface side of the right side wall **11b**. The Y-axis motor **15** is mounted on the mount frame **14**. The Y-axis motor **15** comprises, for example, a stepper motor. The follower gear **17** is engaged with the drive gear **16**. The diameter of the drive gear **16** is less than the diameter of the follower gear **17**. The drive gear **16** is provided on the output shaft of the Y-axis motor **15**. The rotational drive force of the Y-axis motor **15** is transmitted to the drive roller **12** via the drive gear **16** and the follower gear **17** by the rotation of the Y-axis motor **15** to cause the rotation of the drive roller **12**.

The left and right end sides of the pinch roller **13** are supported rotatably by the sidewalls **11a** and **11b**. The sidewalls **11a** and **11b** support the pinch roller **13** so as to be slightly movable in the up and down direction, i.e. the thickness-wise direction of the workpiece **101**. The pinch roller **13** is provided with a roller portion **13a**. The roller portion **13a** is disposed on each side of the shaft of the pinch roller **13**. The diameter of the shaft of the roller portion **13a** is greater than the diameter of the shaft of the pinch roller **13**. A sensor **76** (see FIG. **5**) is configured to detect the insertion of the front end portion of the holding sheet **10** from the front side. Though not illustrated in detail, the sensor **76** is disposed between the roller portion **13a** and the drive roller **12**.

Thus, left and right edge portions **10a** and **10b** of the holding sheet **10** are held between the drive roller **12** and the roller portions **13a** of the pinch roller **13**. The feed mechanism **7** feeds the holding sheet **10** in the front and rear direction by the rotation of the drive roller **12** driven by the Y-axis motor **15** with the edge portions **10a** and **10b** of the holding sheet **10** held between the drive roller **12** and the roller portions **13a**.

[Explanation of Transfer Mechanism **8**]

The transfer mechanism **8** is explained in detail hereinafter with reference to FIGS. **1** and **2**. The transfer mechanism **8** transfers the cut head **5** in the left and right direction crossing the direction in which the holding sheet **10** is fed. The transfer mechanism **8** is provided with components such as a carriage **19**, guide shafts **21** and **22**, a mount plate **24**, an X-axis motor **25**, a pulley shaft **26**, a drive gear **27**, a left-side timing pulley **28**, a follower gear **29**, a right-side timing pulley **30**, and a timing belt **31**.

The guide shafts **21** and **22** extend in the left and right direction and are disposed between the left and right sidewalls **11a** and **11b** so as to be located behind the pinch roller **13**. A guide groove **21a** is provided on the upper surface portion of the guide shaft **21** and on the lower surface portion of the guide shaft **22** so as to extend from the left end to the right end of each of the guide shafts **21** and **22**. The carriage **19** is provided with a pair of protrusions provided one on the upper side portion and one on the lower portion. The protrusions are configured to engage with the guide grooves **21a** from the upper side and the underside. The carriage **19** is supported slidably in the left and right direction by the guide shafts **21** and **22** through the engagement of the protrusions and the guide grooves **21a**.

A mount plate **24** is attached to the outer surface side of the left sidewall **11a**. A mount frame **24** is attached to the outer surface side of the right sidewall **11b**. A pulley shaft **26** is provided rotatably in the front side of the X-axis motor **25**. The pulley shaft **26** extends in the up and down direction. The drive gear **27** is fixed to the output shaft of the X-axis motor **25**. The pulley shaft **26** rotatably supports the left-side

timing pulley 28 and the follower gear 29. The timing pulley 28 and the follower gear 29 are structurally integral and thus, rotate as one. The follower gear 29 meshes with the drive gear 27.

The right-side timing pulley 30 is rotatably mounted on the mount frame 14. The right-side timing pulley 30 and the left-side timing pulley 28 are wound with an endless timing belt 31 which extends horizontally along the left and right direction. The intermediate portion of the timing belt 31 is connected to a rear surface portion of the carriage 19.

When the X-axis motor 25 is rotated, the rotational drive of the X-axis motor 25 is transmitted to the timing belt 31 via the drive gear 27, the follower gear 29, and the left-side timing pulley 28 to cause the carriage 19 to be moved in the left and right direction. As later described in detail, the carriage 19 is provided with the cut head 5. Thus, the movement of the carriage 19 in the left and right direction results in the movement of the cut head 5 in the left and right direction.

[Explanation of Scanner 60]

A description will be given on a scanner 60 with reference to FIG. 2. The scanner 60 is configured to optically read the color or the design of the workpiece 101. More specifically, the scanner 60 reads the images on the surface of the workpiece 101 transferred by the transfer mechanism 7. The scanner 60 may comprise a CIS (contact image sensor). Though not shown in detail, the scanner 60 includes an image capturing element and a light source. The image capturing element comprises multiple sensors aligned in the left and right direction (X direction). The scanner 60 is located behind the guide shaft 21. The width of the scanner 60 taken along the left and right direction is substantially identical to the width of the holder sheet 10 taken along the left and right direction.

The light source of the scanner 60 emits light toward the surface of the workpiece 101 held by the holding sheet 10 disposed on the platen 3. The light emitted from the light source reflects off the surface of the workpiece 101. The scanner 60 reads the image of the surface of the workpiece 101 with the contact glass placed in close proximity of the upper surface of the workpiece 101. The scanner 60 reads the image of the region in which the adhesive layer 10v of the holding sheet 10 is formed. The image capturing element captures images of light reflecting off of the workpiece 101.

[Explanation of Cut Head 5]

The cut head 5 is explained with reference to FIGS. 2 and 3. The cut head 5 is provided with the carriage 19, a cartridge holder 32 and an up-down drive mechanism 33. The cartridge holder 32 is disposed in the front side of the carriage 19 and the up-down drive mechanism 33 is disposed in the rear side of the carriage 19. The up-down drive mechanism 33 drives the cartridge holder 32 as well as the cartridge 4 in the up and down direction (Z direction).

The carriage 19 is provided with a front wall 19a, a rear wall 19b, upper arm 19c, and a lower arm 19d. The upper and lower arms 19c and 19d connect the front and rear walls 19a and 19b. The carriage 19 is shaped so as to surround the front and rear sides as well as the upper and lower sides of the guide shafts 21 and 22. A forwardly oriented Z-axis motor 34 is attached to the rear wall 19b of the carriage 19.

The up-down drive mechanism 33 is provided with a transmission mechanism and the Z-axis motor 34. The transmission mechanism is provided between the Z-axis motor 34 and the cartridge holder 32. The transmission mechanism is configured to decelerate the rotary motion of the Z-axis motor 34 and convert the rotary motion to the up and down movement of the cartridge holder 32. The trans-

mission mechanism and the Z-axis motor 34 serve as the up-down drive mechanism 33.

When the Z-axis motor 34 is driven in the forward and reverse directions, the rotary motion of the Z-axis motor 34 is converted into the up and down movement via the transmission mechanism to cause the cartridge holder 32 as well as the cartridge 4 to be moved in the lifted position or the lowered position. As a result, the cartridge 4 held by the cartridge holder 32 is moved between the lowered position for cutting the workpiece 101 using the cutting blade 6 (indicated by a solid line in FIG. 3) and the lifted position (indicated by a double-dot chain line in FIG. 3) in which the blade tip 6a of the cutting blade 6 is spaced apart from the workpiece 101 by a predetermined distance.

In attaching the cartridge 4 to the cartridge holder 32, the blade tip 6a contacts the workpiece 101 when the cartridge 4 is in the lowered position. The pressure exerted on the blade tip 6a is controlled, by a control circuit 61 described hereinafter, to an appropriate pressure suitable for performing the cutting operation based on the amount of rotation of the Z-axis motor 34. The pressure exerted on the blade tip 6a is hereinafter referred to as the cutting pressure.

The cartridge holder 32 is provided with a holder frame 35, an upper holder 36, and a lower holder 37. The holder frame 35 is driven up and down by the up-down drive mechanism 33. The upper holder 36 and the lower holder 37 are secured to the holder frame 35. More specifically, the front wall 19a of the carriage 19 is provided with a cover member 38 configured to cover the left and right sides of the carriage 19 from the front side. The holder frame 35, serving as a movable portion, is provided between the right side projection 38a and the left side projection 38b of the cover member 38. The upper and lower surface as well as the front surface of the holder frame 35 are opened. The upper holder 36 and the lower holder 37 are shaped like a frame and are installed into the holder frame 35. The cartridge 4 is inserted through the upper holder 36 and the lower holder 37 from the upper side to be attached to the holder frame 35.

A lever member 40 is provided between the upper holder 36 and the lower holder 37. The lever member 40 is provided with a pair of left arm 41 and a right arm 42 and an operating portion 43 provided so as to connect the tips of the arms 41 and 42. The lever member 40 is supported swingably by the holder frame 35 with the upper end sides of the arms 41 and 42 serving as the base end. Engagement portions 41a and 42a shaped like small cylinders are provided on the inner surface sides of the arms 41 and 42, respectively. The engagement portions 41a and 42a are configured to be capable of engagement with later described engagement subject portion 54a provided at the cartridge 4.

The lever member 40 is configured to swing about the base ends of the arms 41 and 42 so as to be switchable between a locked position illustrated in FIG. 3 and an unlocked position. The lever member may be switched from the locked position to the unlocked position by pulling the operating portion 43 forward as viewed in FIG. 3. The cartridge 4 is secured to the lower holder 37 by the engagement of the engagement portions 41a and 42a with the engagement subject portion 54a of the cartridge 4 when the lever member 40 is in the locked position. In contrast, the lever member 40 is unlocked when the user pulls the operating portion 43 forward so as to be swung from the locked position to the unlocked position, thereby causing the engagement portions 41a and 42a to be spaced apart from the engagement subject portion 54a. The user is thus, allowed to readily and reliably cause attachment and detachment of the cartridge using the lever member 40.

## [Explanation of Cartridge 4]

The cutting apparatus 1 is provided with multiple cartridges 4 equipped with blades 6 suitable for the types of workpiece to be cut. The user may replace the cutting blade 6 provided to each cartridge 4. A description is given hereinafter on the cartridge 4 with reference to FIG. 4.

The cartridge 4 comprises an outer case 50. The outer case is provided with a case body 51, a cap portion 52 provided on one end of the case body 51, and a grip portion 53 provided on the other end of the case body 51. The case body 51 is shaped like a cylinder extending in the up and down direction. The cap portion 52 is provided with a large-diameter portion 54 being fitted into the lower end portion of the case body 51 and a small-diameter portion 55. Thus, the cap portion 52 is shaped like a stepped cylinder having an enclosed bottom. The engagement subject portion 54a is located on the upper end of the large-diameter portion 54. The engagement subject portion 54a is placed in contact with the engagement portions 41a and 42a of the lever member 40. The lower end of the large-diameter portion 54 establishes a fitting engagement with the lower holder 37 of the cartridge holder 32. The cap portion 52 has a planar lower surface portion 50a and a hole is formed on the lower surface portion 50a to allow the tip 6a of the cutting blade 6 to pass therethrough.

The grip portion 53 comprises a lid plate 56, a grip plate 57, and a rear surface plate 58 which are structurally integral. The lid plate 56 is fixed to the upper end of the case body 51. The grip plate 57 and the rear surface plate 58 are located on the upper side of the lid plate 56. The grip plate 57 is located on a lateral center of the lid plate 56 so as to be oriented in the longitudinal direction.

The cutting blade 6 comprises a cutter shaft 47 and the blade tip 6a which are structurally integral. The cutter shaft 47 is installed in the outer case 50 of the cartridge 4. The cutter shaft 47 occupies most of the cutting blade 6 and is shaped like a round bar. The blade tip 6a is located on one end of the cutting blade 6. The blade portion of the cutting blade 6 is shaped like a letter V which is slanted with respect to the workpiece 101. Further, a bearing is provided inside the case body 51. The bearing supports the cutter shaft 47 rotatably about its central axis 50c. The blade tip 6a protrudes from the lower surface portion 50a of the cap portion 52.

When cutting the workpiece 101, the control circuit 61 moves the cartridge 4 mounted on the cartridge holder 32 to the lowered position by the up-down drive mechanism 33 and sets the cutting pressure. When the cartridge 4 is in the lowered position, the blade tip 6a penetrates through the workpiece 101 placed on the holding sheet 10 and further slightly penetrates into the holding sheet 10. The workpiece 101 is cut by relatively moving the holding sheet 10 and the cutting blade 6 in the X and Y directions using the feed mechanism 7 and the transfer mechanism 8 with the cartridge 4 placed in the lowered position. In the cutting apparatus 1, an XY coordinate system is employed for example in which the origin O is set to the upper left corner of the adhesive layer 10v of the holding sheet 10 illustrated in FIG. 1. The workpiece 101 and the cutting blade 6 are moved in a relative manner based on the XY coordinate system.

## [Electrical Configuration of Cutting Apparatus 1]

Next, a description will be given on a control system of the cutting apparatus 1 with reference to FIG. 5. The control circuit 61 is responsible for the overall control of the cutting apparatus 1. The control circuit 61 is primarily configured by a computer (CPU). The control circuit 61 is electrically

connected to a ROM 62, a RAM 63, and external memory 65. The ROM 62 stores items such as a cut control program 500 for controlling the cutting operation and pattern data 600. The cut control program 500 contains display control programs S15A, S15B, S15C, and S15D for controlling how information is presented on the display 9a. The RAM 63 stores images of workpieces 101 read by the scanner 60 and the RGB values 710 of the workpieces 101 calculated based on the images of the workpieces 101 read by the scanner 60. External memory 65 stores cut data 720 used for cutting patterns.

A pattern may be a monolithic pattern colored in a single color or a pattern formed of multiple parts colored in different colors or have different designs. When the pattern is formed of multiple parts having different colors or designs, pattern data 600 contains pattern number 605, parts number i, parts shape 620, parts RGB 630, parts location 640, and parts size 650. The details of the pattern data 600 will be later described in detail. The display 9a is capable of displaying both the single colored pattern and the pattern formed of multiple patterns having different colors or designs.

Signals are inputted to the control circuit 61 from switches 9b, etc. The control circuit 61 is electrically connected to scanner 60, sensor 76, display 9a, and the touch panel 9c. The user is allowed to select the desired patterns and various types of processing modes, and specify various parameters by operating the switches 9b or the touch panel 9c while referring to the information provided through the display 9a. Further, the control circuit 61 is electrically connected to drive circuits 67, 68, and 69 controlling driving a Y-axis motor 15, an X-axis motor 25, and a Z-axis motor 34, respectively. The control circuit 61 is configured to control elements such as the Y-axis motor 15, the X-axis motor 25, the Z-axis motor 34 to automatically execute a cutting operation on the workpiece 101 placed on the holding sheet 10.

## [Cut Control Program 500]

Referring to FIGS. 6 to 11, a description is given on the cut control program 500. The cut control program 500 is executed by the control circuit 61 of the cutting apparatus 1. For example, when the user touches a key on the touch panel 9c that causes transition to the pattern selection screen 110, the control circuit 61 reads the cut control program 500 from the ROM 62 and executes the same. Upon execution of the cut control program 500, the control circuit 61 invokes the pattern selection screen 110 on the display 9a. Each of the steps indicated in the flowchart represents the process steps executed by the control circuit 61.

At step S11, the control circuit 61 receives user input of the selection of one or more patterns to be cut using the cut mechanism. When the user depresses a location on the touch panel 9c displaying the desired pattern 120 in the pattern selection screen 110 illustrated in FIG. 7 with a touch pen or the user's finger, the touch panel 9c detects the pattern 120 selected by the user from multiple patterns.

Then, at step S12, the control circuit 61 stores pattern data 600 of the pattern 120 selected by the user, which was stored in the ROM 62, to the RAM 63.

Then, at step S13, the control circuit 61 invokes a parts screen 130 presenting parts 150, 160, and 170 making up the pattern 120 on the display 9a as illustrated in FIG. 8.

One example of a pattern data 600 will be described with reference to FIG. 8. The pattern data 600 includes information such as a pattern number 605, parts number i, parts shape 620, and parts RGB value 630. The pattern number 605 is unique to each pattern. One example of pattern



number **605** is AR-G007. Parts number *i* is unique to each part. The part number *i* is a positive integer for example. The parts shape **620** is coordinate data represented by X and Y coordinates. More specifically, coordinate data is collection of coordinates representing the shape of a pattern when the origin is located at the center of the pattern. Parts RGB value **630** is information pre-stored in the ROM **62** and represents colors of the parts. For example, RGB value (R, G, B) of part **150** is (255, 0, 0). RGB value (R, G, B) of part **160** is (255, 0, 0). RGB value (R, G, B) of part **170** is (0, 0, 255).

Next, at step **S15A**, the control circuit **61** executes a display control program.

Then, at step **S17A**, the control circuit **61** executes a cut process. The control circuit **61** terminates the cut control program **500** after completing step **S17A**.

[Display Control Program **S15A** of First Embodiment]

A description will be given in detail on a display control program **S15A** with reference to FIGS. **9** and **10**. The control circuit **61** begins the display control program **S15A** with step **S21** of FIG. **9**.

At step **S21**, the control circuit **61** judges whether or not a color change key (not shown) has been pressed. More specifically, the control circuit **61** presents the color change key on the display **9a**. When user has pressed the touch panel **9c** disposed above the color change key, the touch panel **9c** detects the pressing of the color change key. When the touch panel **9c** has detected the pressing of the color change key, the control circuit **61** judges that the color change key has been pressed. The control circuit **61** proceeds to step **S23** after judging that the color change key has been pressed (**S21**: YES). When the user has pressed a key on the touch panel **9c** that is different from the color change key, the touch panel **9c** makes a detection that the color change key has not been pressed. When the touch panel **9c** has detected that the color change key has not been pressed, the control circuit **61** judges that the color change key has not been pressed. The control circuit **61** proceeds to step **S22** after judging that the color change key has not been pressed (**S21**: NO).

At step **S22**, the control circuit **61** judges whether or not the parts to be cut have been selected. More specifically, the user is to press the parts which the user desires to cut without changing their color on the part screen **130** in order to start cutting of parts. The control circuit **61** judges that the parts have been selected when the touch panel **9c** has detected that the parts have been pressed on the parts screen **130**. The control circuit **61** terminates the process of step **S15A** when judging that parts have been selected on the touch panel **9c** (**S22**: YES). The control circuit **61** returns the process flow back to step **S21** when judging that parts have not been selected on the touch panel **9c** (**S22**: NO).

At step **S23**, the control circuit **61** accepts selection of one part for which the color is to be changed from the multiple choice of parts. The touch panel **9c** detects the part that the user has selected from the multiple choice of parts when the user presses the location of the touch panel **9c** corresponding to the part on the parts screen **130** for which the color is to be changed by a touch pen or the user's finger. The control circuit **61** stores the detected part to the RAM **63**.

Then, at step **S25**, the control circuit **61** makes the scanner **60** read an image of the color or the design of the workpiece **101**. More specifically, the control circuit **61** rotates the Y-axis motor **15** in a predetermined direction through the drive circuit **67**. The rotation of the Y-axis motor **15** in the predetermined direction causes rotation of the drive roller **12**. The rotation of the drive roller **12** causes the holding sheet **10** carrying the workpiece **101** and being placed between the drive roller **12** and the roller portion **13a** to be

fed rearward. The scanner **60** reads an image of the workpiece **101** attached to the holding sheet **10**. The control circuit **61** stores the read image of the workpiece **101** to the RAM **63**. After reading the image of the workpiece **101**, the control circuit **61** rotates the Y-axis motor **15** in the direction opposite of the predetermined direction through the drive circuit **67**. The rotation of the Y-axis motor **15** in the opposite direction causes the drive roller **12** to rotate in a direction opposite of the direction rotated during image capturing thereby feeding the holding sheet **10** in the forward direction. The drive roller **12** returns the holding sheet **10** to the original position by feeding the holding sheet **10** forward.

Then at step **S27**, the control circuit **61** calculates an RGB value **710**, being the color of the workpiece **101**, from the image of the workpiece **101** read by the scanner **60** at step **S25**. More specifically, the control circuit **61** acquires analog data of the R (red) component for each pixel of the image of the workpiece **101** read by the scanner **60**. The control circuit **61** converts, pixel by pixel, the analog data to digital data (or a gradation data) ranging from 0 to 255 by AD conversion. The control circuit **61** calculates an average value of the digital data of the converted pixels for the R component. More specifically, the control circuit **61** calculates the average value of the multiple pixels by dividing the sum of the digital data of the converted pixels by the number of pixels read. The control circuit **61** performs the same processes for the G (green) component and the B (blue) component. The control circuit **61** calculates the RGB value of the workpiece **101** based on the average value of digital data for all of the pixels belonging to each of the RGB components. One example of the RGB value **710** calculated for the workpiece **101** is (128, 0, 0). The control circuit **61** stores the RGB value **710** of the workpiece **101** into the RAM **63**.

Then, at step **S29**, the control circuit **61** is converts the color of the part selected at **S23** into the RGB value calculated at step **S27**. More specifically, the control circuit **61** converts the RGB value **630** of the part pre-stored in ROM **62** into the RGB value **710** of the workpiece read by the scanner **60**. The control circuit **61** assigns the RGB value **710** into the RGB value **630**. For example, the RGB value **710** (128, 0, 0) of the workpiece **101** is assigned to the RGB value **630** (255, 0, 0) of part **150** illustrated in FIG. **8**. As a result, the RGB value of the part **150** is changed to (128, 0, 0). Further, the RGB value **710** (255, 255, 255) of a workpiece different from the workpiece **101** is assigned to an RGB value (255, 0, 0) of part **160**. As a result, the RGB value of the part **160** is changed to (255, 255, 255).

Next, at step **S31**, the control circuit **61** displays the selected pattern on the display **9a** with multiple parts colored in the colors changed at step **S29**. More specifically, the control circuit **61** displays the parts screen **131** on the display **9a** in the changed color as illustrated in FIG. **10**. In this example, the display **9a** displays part **151** changed to a bright color represented by RGB value **630** (128, 0, 0) and part **161** in a dark color represented by RGB value (255, 255, 255). After completing step **S31**, the control circuit **61** returns the process flow back to step **S21**.

Next, as illustrated in FIG. **11**, a description will be given in detail on cut process **S17A**. The control circuit **61** begins the process **S17A** with step **S43** of FIG. **11**.

The control circuit **61** accepts specification of parts size after the parts have been selected. The control circuit **61** stores parts size **650** specified by the user in the RAM **63**.

At step **S43**, the control circuit **61** judges whether or not the holding sheet **10** has been set. More specifically, the sensor **76**, when detecting that the holding sheet **10** has been

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set, sends a detection signal to the control circuit 61. The control circuit 61 judges that the holding sheet 10 has been set upon receiving the detection signal. The control circuit 61 proceeds to step S45 when judging that the holding sheet 10 has been set (S43: YES). The control circuit 61 repeats step S43 when judging that holding sheet 10 has not been set (S43: NO).

At step S45, the control circuit 61 displays a cut key (not illustrated) on the display 9a which instructs execution of cutting and judges whether or not the cut key has been pressed. The control circuit 61 proceeds to step S47 when judging that the cut key has been pressed (S45: YES). The control circuit 61 repeats step S45 when judging that the cut has not been pressed (S45: NO).

At step S47, the control circuit 61 controls the drive of the transfer unit 20 so as to cut the parts selected at step S41. More specifically, the control circuit 61 acquires the center coordinate of the pattern based on the location of the pattern specified by the user on the touch panel 9c. The control circuit 61 generates coordinate data indicated where the cuts are to be made based on the center coordinate of the pattern as well as the parts shape 620 and the parts size 650 provided in the pattern data 600. The coordinate data establishes its origin O at the upper left corner of the holding sheet 10. More specifically, the control circuit 61 converts the coordinate data provided in the pattern data 600 into coordinate data plotted on the holding sheet 10 so that the origin of the coordinate data of the pattern data 600 and the central coordinate of the selected pattern coincide. The control circuit 61 stores the generated data in the RAM 63 as cut data 720. The control circuit 61 controls the drive of the transfer unit 20 so that the blade tip 6a moves along the coordinates defined in the cut data 720.

Then, at step S49, the control circuit 61 judges whether there are any other parts to be cut. Though not illustrated, the control circuit 61 displays a "NEXT PART" key and an "END" key on the display 9a. The control circuit 61 returns the process flow back to S41 when detecting that the "NEXT PART" key has been pressed (S49: YES) on the touch panel 9c. The control circuit 61 terminates the cut process S17A when detecting that the "END" key has been pressed on the touch panel 9c (S49: NO). The control circuit 61 terminates the cut control program 500 after terminating the cut process S17A.

## Effects of First Embodiment

At step S29, the control circuit 61 converts the color of the selected parts into the color read by the scanner 60. The control circuit 61 displays the pattern on the display 9a with the parts colored in the changed colors. Thus, the user is allowed to display the desired parts of the selected pattern in the color of the workpiece 101 available to the user. Thus, the user is allowed to be aware of the how the combination of parts colored in the color of the workpiece 101 would look prior to the execution of pattern cutting.

[Display Control Program S15B of Second Embodiment]

A description will be given on the configuration of a display control program S15B of the second embodiment with reference to FIGS. 12 and 13. The second embodiment differs from the first embodiment in that the display control program S15B is provided instead of display control program S15A as illustrated in FIG. 12. The control circuit 61 begins the display control program S15B with step S51 indicated in FIG. 12.

At step S51, the control circuit 61 determines whether or not the color change key has been pressed as was the case

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in step S21. More specifically, the control circuit 61 displays the color change key on the display 9a. When user has pressed the touch panel 9c disposed above the color change key, the touch panel 9c detects the pressing of the color change key. When the touch panel 9c has detected the pressing of the color change key, the control circuit 61 judges that the color change key has been pressed. The control circuit 61 proceeds to step S53 after judging that the color change key has been pressed (S51: YES). When the user has pressed a key on the touch panel 9c that is different from the color change key, the touch panel 9c makes a detection that the color change key has not been pressed. When the touch panel 9c has detected that the color change key has not been pressed, the control circuit 61 judges that the color change key has not been pressed. The control circuit 61 proceeds to step S52 after judging that the color change key has not been pressed (S51: NO).

At step S52, the control circuit 61 judges whether or not the parts to be cut have been selected as was the case in step S22. More specifically, the user is to press the parts which the user desires to cut without changing their color on the parts screen 130 in order to start cutting of parts. The control circuit 61 judges that the parts have been selected when the touch panel 9c has detected that the parts have been pressed on the parts screen 130. The control circuit 61 terminates the process of step S15B when judging that parts have been selected on the touch panel 9c (S52: YES). The control circuit 61 returns the process flow back to step S51 when judging that parts have not been selected on the touch panel 9c (S52: NO).

Then, at step S53, the control circuit 61 makes the scanner 60 read an image of the workpiece 101 as was the case in step S25.

At step S55, the control circuit 61 calculates an RGB value, being the color of the workpiece 101, from the image of the workpiece 101 read by the scanner 60 at step S53 as was the case in step S27.

Then, at step S57, the control circuit 61 displays a parts screen 132 in which palettes 181, 182, and 183 of the RGB values calculated at S55 as illustrated in FIG. 13. A palette represents a color of the workpiece 101 read by the scanner 60 and presents a choice of color to be applied to the parts of a pattern. The display 9a displays the palettes 181, 182, and 183 for the RGB values of the workpiece 101 calculated at step S55 so as to be laterally aligned below parts 152, 162, and 172.

Then, at step S59, the control circuit 61 judges whether it is desired to add any other colors to the palette. The control circuit 61 displays the add key (not illustrated) on the display 9a. When user has pressed the touch panel 9c disposed above the add key, the touch panel 9c detects the pressing of the add key. When the touch panel 9c has detected the pressing of the add key, the control circuit 61 judges that the add key has been pressed. The control circuit 61 returns the process flow back to step S53 after judging that the add key has been pressed (S59: YES). The control circuit 61 proceeds to step S61 after judging that the user has pressed an "end palette addition key" (S59: NO).

At step S61, the control circuit 61 accepts selection of one part 152 for which the color is to be changed from the multiple choice of parts, namely 152, 162, and 172 as was the case in step S23. The touch panel 9c detects the part that the user has selected from the multiple choice of parts, namely 152, 162, and 172 when the user presses the location of the touch panel 9c corresponding to the desired part 152

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on the parts screen 132 by a touch pen or the user's finger. The control circuit 61 stores the detected part 152 to the RAM 63.

Then, at step S63, the control circuit 61 accepts selection of one palette 181 from the multiple choice of palettes, namely 181, 182, and 183. The touch panel 9c detects the palette 181 that the user has selected from the multiple choice of palettes, namely 181, 182, and 183 when the user presses the location of the touch panel 9c corresponding to the desired palette 181 on the parts screen 132 by a touch pen or the user's finger. The control circuit 61 stores the detected palette 181 to the RAM 63.

Then at step S65, the control circuit 61 converts the color of the part selected at step S61 to the color of the palette selected at step S63. The control circuit 61 converts the RGB value stored in the ROM 62 associated with part selected at step S61 to the RGB value of the workpiece 101 corresponding to the color of the palette selected at step S63. For example, the control circuit 61 assigns the RGB value (255, 255, 0) of the workpiece 101 corresponding to color of the palette 181 to the RGB value (255, 0, 0) of the part 152 selected at step S61. As a result, the RGB value of the part 152 is changed to (255, 255, 0).

Then, at step S66, the control circuit 61 displays the pattern 142 on the display 9c with the parts colored in the changed colors as was the case in step S31. For example, the display 9a displays the pattern 142 including part 152 being colored in RGB value 630 (255, 255, 0) which was changed in step S65.

Then, at step S69, the control circuit 61 judges whether or not "accept combination key" (not illustrated) has been pressed. The touch panel 9c detects pressing of the "accept combination key" when the user presses the location of the touch panel 9c corresponding to the "accept combination key" on the parts screen 130. When the touch panel 9c has detected the pressing of the "accept combination key", the control circuit 61 judges that the "accept combination key" has been pressed. The control circuit 61 terminates the display control program S15B after judging that the "accept combination key" has been pressed on the touch panel 9c (S69: YES). The control circuit 61 returns the process flow back to step S61 after judging that the add key has been pressed on the touch panel 9c (S69: NO).

## Effects of the Second Embodiment

At step S65, the control circuit 61 converts the color of the parts selected by the user into the color selected from multiple palettes which have been read by the scanner 60. At step S66, the control circuit 61 displays the pattern on the display 9a with the multiple parts colored in the changed colors. Thus, the user is allowed to display the desired parts of the selected pattern in the colors of the multiple workpieces 101 available to the user. Thus, the user is allowed to be aware of how the combination of parts colored in the colors of the workpieces 101 would look prior to the execution of pattern cutting.

At step S57, the control circuit 61 displays the palettes 181, 182, and 183 one next to another on the display 9a. The user is allowed to select a color of the workpiece 101 to be applied to each part by pressing the touch panel 9c while viewing the displayed palettes 181, 182, and 183.

[Display Control Program S15C of the Third Embodiment]

A description will be given on a display control program S15C of the third embodiment with reference to FIGS. 14 and 15. The third embodiment differs from the first embodiment in that the display control program S15C is provided

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instead of display control program S15A as illustrated in FIG. 14. The control circuit 61 begins the display control program S15C with step S71 indicated in FIG. 14.

At step S71, the control circuit 61 judges whether or not the color change key has been pressed as was the case in step S21. More specifically, the control circuit 61 displays the color change key (not shown) on the display 9a. When user has pressed the touch panel 9c disposed above the color change key, the touch panel 9c detects the pressing of the color change key. When the touch panel 9c has detected the pressing of the color change key, the control circuit 61 judges that the color change key has been pressed. The control circuit 61 proceeds to step S73 after judging that the color change key has been pressed (S71: YES). When the user has pressed a key on the touch panel 9c that is different from the color change key, the touch panel 9c makes a detection that the color change key has not been pressed. When the touch panel 9c has detected that the color change key has not been pressed, the control circuit 61 judges that the color change key has not been pressed. The control circuit 61 proceeds to step S72 after judging that the color change key has not been pressed (S71: NO).

At step S72, the control circuit 61 judges whether or not the parts to be cut have been selected as was the case in step S22. More specifically, the user is to press the parts which the user desires to cut without changing their color on the parts screen 130 in order to start cutting of parts. The control circuit 61 judges that the parts have been selected when the touch panel 9c has detected that the parts have been pressed on the parts screen 130. The control circuit 61 terminates the process of step S15C when judging that parts have been selected on the touch panel 9c (S72: YES). The control circuit 61 returns the process flow back to step S71 when judging that parts have not been selected on the touch panel 9c (S72: NO).

Then, at step S73, the control circuit 61 makes the scanner 60 read an image of the workpiece 101 as was the case in step S25.

Then, at step S75, the control circuit 61 calculates an RGB value, being the color of the workpiece 101, from the image of the workpiece 101 read by the scanner 60 at step S73. RGB value 630 of the workpiece 101 is (250, 0, 0) for example. The control circuit 61 stores RGB value 710 of the workpiece 101 to the RAM 63.

Then, at step S77, the control circuit 61 executes an extraction process that extracts a part having a color most closely approximating the RGB value calculated at step S75.

[Parts Extraction Process S77]

A description will be given on a parts extraction process S77 with reference to FIG. 15. The control circuit 61 begins the parts extraction process S77 with step S131 indicated in FIG. 15.

At step S131, the control circuit 61 initializes the parts number "i" and minimum difference "Dm". More specifically, the control circuit 61 assigns 1 to the parts number i. Further, the control circuit 61 assigns a value to the minimum difference Dm which is greater than the maximum difference  $255^2 + 255^2 + 255^2 (=195075)$  of the colors. One example of such value may be, 200000.

Then, at step S133, the control circuit 61 calculates difference "Di" between the RGB value of the workpiece 101 read by the scanner 60 and the pre-stored RGB value of the ith part. More specifically, when the RGB value of the ith part is (Ri, Gi, Bi) and the RGB value of the workpiece 101 is (R,G,B), the control circuit 61 may obtain the difference Di by the equation difference  $Di = (Ri - R)^2 + (Gi - G)^2 + (Bi - B)^2$ . For example, when the RGB value of the first part

is  $(R_i, G_i, B_i) = (255, 0, 0)$  and the RGB value of the workpiece **101** is  $(250, 0, 0)$ , the difference  $D_i$  may be obtained by difference  $D_i = (R_1 - R)^2 + (G_1 - G)^2 + (B_1 - B)^2 = (255 - 250)^2 + (0 - 0)^2 + (0 - 0)^2 = 25$ .

At step **S135**, the differences between the RGB value of the workpiece and RGB values of each of the parts are compared one by one in order to extract the RGB value most closely approximating the RGB value of the workpiece. The control circuit **61** judges whether or not difference  $D_i$  is less than the minimum difference  $D_m$ . The control circuit **61** proceeds to step **S137** after judging that difference  $D_i$  is less than the minimum difference  $D_m$  (**S135**: YES). The control circuit **61** proceeds to step **S140** after judging that difference  $D_i$  is not less than the minimum difference  $D_m$  (**S135**: NO). When the minimum difference  $D_m = 200000$  and the difference  $D_1 = 25$ , the process flow proceeds to step **S137** since minimum difference  $D_m >$  difference  $D_1$ .

At step **S137**, the control circuit **61** assigns difference  $D_i$  to minimum difference  $D_m$ . The control circuit **61** assigns difference  $D_1 = 25$  to minimum difference  $D_m = 200000$  and thus, the minimum difference  $D_m$  is updated to 25 (minimum difference  $D_m = 25$ ).

Then, at step **S139**, the control circuit **61** assigns parts number  $i$  to parts number  $i_m$  having the minimum difference. For example, the control circuit **61** assigns parts number  $i = 1$  to parts number  $i_m$  and thus, parts number  $i_m$  is updated to 1 (parts number  $i_m = 1$ ).

Then, at step **S140**, the control circuit **61** proceeds to the next parts number  $i$  and thus, the control circuit **61** increments the parts number  $i$  by 1. For example, when the parts number  $i = 1$ , the control circuit **61** is updated to parts number  $i = 1 + 1 = 2$ .

Then, at step **S141**, the control circuit **61** judges whether or not difference  $D_i$  for every part has been calculated. More specifically, parts number "in" is stored in the RAM **63** for every pattern. The control circuit **61** proceeds to step **S143** after judging that parts number  $i$  is greater than parts number in (**S141**: YES). The control circuit **61** returns the process flow back to step **S133** after judging that parts number  $i$  is not greater than parts number in (**S141**: NO). When parts number  $i = 2$  and parts number in = 3, the control circuit **61** makes a judgement that the parts number  $i$  is not greater than parts number in since parts number  $i <$  parts number in.

Then, at step **S143**, the control circuit **61** extracts the RGB value of the  $i_m$ th part. For example, when  $i_m = 1$ , the control circuit **61** extracts the RGB value  $(R_1, G_1, B_1) = (255, 0, 0)$  of the first part. After completing step **S143**, the control circuit **61** terminates the process of step **S77** and proceeds to step **S79**.

At step **S79**, the control circuit **61** converts the RGB value of the part extracted at step **S77** to the RGB value calculated at step **S75**. More specifically, the control circuit **61** assigns the RGB value **710** of the workpiece calculated at **S75** to the RGB value **630** of the part extracted at step **S77** which is pre-stored in the ROM **62**. For example,  $(250, 0, 0)$  is assigned to the RGB value **630**  $(255, 0, 0)$  of parts **150** indicated in FIG. **8** most closely approximating the RGB value **710**  $(250, 0, 0)$  of the workpiece **101**.

At step **S80**, the control circuit **61** displays the pattern containing multiple parts whose colors were changed at step **S79** on the display **9a**. More specifically, the control circuit **61** invokes the parts screen **131** presenting the pattern in changed colors on the display **9a**. For example, the display **9a** displays part **151** which has been changed to a slightly bright color represented by RGB value **630**  $(250, 0, 0)$ . After completing step **S80**, then control circuit **61** returns the process flow back to **S71**.

At step **S77**, the control circuit **61** extracts the part most closely approximating the color read by the scanner **60**. As a result, cutting apparatus **1** automatically changes the color of a part to a color most closely approximating the color read by the scanner **60** without requiring the user to select the part for which the color is to be changed. Thus, the user is allowed to view the most appropriate combination of parts without requiring the user to select the parts.

[Display Control Program **S15D** of Fourth Embodiment]

A description will be given on a display control program **S15D** of the fourth embodiment with reference to FIGS. **16** and **19**. The fourth embodiment differs from the first embodiment in that the display control program **S15D** is provided instead of display control program **S15A** as illustrated in FIG. **16**. The control circuit **61** begins the display control program **S15D** with step **S91** indicated in FIG. **16**.

At step **S91**, the control circuit **61** accepts selection of one part **220** from the multiple choice of parts, namely **220** and **230** illustrated in FIG. **17**. For example, suppose that the touch panel **9c** has detected that the user has selected part **220** illustrated in FIG. **17**. The control circuit **61** stores the detected part **220** to the RAM **63**.

At step **S93**, the control circuit **61** judges whether or not a change is to be made on the design. More specifically, the control circuit **61** judges whether or not a design change key has been pressed. The control circuit **61** displays the design change key (not shown) on the display **9a**. When user has pressed the touch panel **9c** disposed above the design change key, the touch panel **9c** detects the pressing of the design change key. When the touch panel **9c** has detected the pressing of the design change key, the control circuit **61** judges that the design change key has been pressed. The control circuit **61** proceeds to step **S95** after judging that the design change key has been pressed (**S93**: YES). When the user has pressed a key on the touch panel **9c** that is different from the design change key, the touch panel **9c** makes a detection that the design change key has not been pressed. When the touch panel **9c** has detected that the design change key has not been pressed, the control circuit **61** judges that the design change key has not been pressed. The control circuit **61** terminates step **S15D** after judging that the design change key has not been pressed (**S93**: NO).

At step **S95**, the control circuit **61** reads an image **310** of the workpiece **101** using the scanner **60** as was the case in step **S25**.

At step **S97**, the control circuit **60** displays the part **220** selected at step **S91** on the display **9a** using the image **310** of the design of the workpiece **101** read at step **S95** as the background as illustrated in FIG. **18**.

At step **S99**, control circuit **60** judges whether or not the size **650** of one of the parts among the selected parts have been changed in order to uniform the size of the parts. More specifically, the control circuit **61** judges whether the default size **650** of the part pre-stored in the ROM **62** is identical to the size **650** of the part once changed and stored in the RAM **63**. The control circuit **61** proceeds to step **S101** after judging that the sizes **650** of the part are not identical (step **S99**: YES). The control circuit **61** proceeds to step **S103** after judging that the sizes **650** of the parts are identical (step **S99**: NO).

At step **S101**, the control circuit **61** accepts specification of the layout of the part selected at step **S91** on the design **310** of the workpiece **101** read by the scanner **60**. More specifically, the control circuit **61** accepts specification of the location of the part through the touch panel **9c**. The user is

to specify the location where the user wishes to place the part on the design 310 displayed on the display 9a by pressing the desired location on the touch panel 9c. The control circuit 61 identifies the central coordinate of the part at the location specified by the user and stores the coordinate in the RAM 63.

At step S103, the control circuit 61 accepts specification of the size 650 of the part through the touch panel 9c. The control circuit 61 stores the specified size 650 of the part in the RAM 63. The control circuit 61 accepts specification of the layout of the part selected at step S91 on the design 310 of the workpiece 101 read by the scanner 60. More specifically, the control circuit 61 accepts specification of the location of the part through the touch panel 9c. The user is to specify the location where the user wishes to place the part on the design 310 displayed on the display 9a by pressing the desired location on the touch panel 9c with the user's finger. The control circuit 61 identifies the central coordinate of the part at the location where the user released the pressure applied to the touch panel 9c with the user's finger and stores the identified central coordinate in the RAM 63 as location 640 of the RAM 63.

Then, at step S105, the control circuit 61 judges whether or not to invoke the parts screen. The control circuit 61 displays a preview key (not shown) on the display 9a. When user has pressed the touch panel 9c disposed above the preview key, the touch panel 9c detects the pressing of the preview key. When the touch panel 9c has detected the pressing of the preview key, the control circuit 61 judges that the preview key has been pressed. The control circuit 61 proceeds to step S106 after judging that the preview key has been pressed (S105: YES). The control circuit 61 terminates step S15D after judging that the cut key has been pressed on the touch panel 9c (S105: NO).

Next, at step S106, the control circuit 61 converts the design of the part selected at step S91 into the design laid out according to the specification made at step S101 or 103. The control circuit 61 generates the coordinate data indicating the locations where the cuts are to be made based on the shape 620 of the parts, the location 640 of the parts, and the size 650 of the parts. The control circuit 61 stores an image 310 of the area inside the boundary defined by the locations where the cuts are to be made in the RAM 63. The control circuit 61 stores the coordinate data indicating the locations where the cuts are to be made in the RAM 63 as cut data 720.

Then, at step S107, the control circuit 61 invokes the parts screen 201 illustrated in FIG. 19 on the display 9a. The control circuit 61 reads the image 310 of the region inside the boundary defined by the locations of where the part 220 is to be cut from the RAM 63 and displays pattern 211 on the display 9a with the design of the part 221 changed to the image 310 of the region inside the boundary.

At step S109, the control circuit 61 judges whether or not to change the design 310 of the workpiece 101. More specifically, the control circuit 61 displays the design change key (not illustrated) on the display 9a and judges whether or not the design change key has been pressed on the touch panel 9c. The control circuit 61 returns the process flow to step S95 after judging that the design change key has been pressed (step S109: YES). The control circuit 61 proceeds to step S111 after determining that the design change key has not been pressed (S109: NO).

At step S111, the control circuit 61 judges whether or not to change the location or the size of the parts. More specifically, the control circuit 61 displays a location•size change key (not illustrated) on the display 9a and judges whether or not the location•size key has been pressed on the

touch panel 9c. The control circuit 61 returns the process flow back to step S103 after judging that the location•size key has been pressed (S111: YES). The control circuit 61 proceeds to step S113 after judging that the location•size key has not been pressed (S111: NO).

At step S113, the control circuit 61 determines whether or not an OK key has been pressed. The control circuit 61 displays the OK key (not illustrated) on the display 9a and determines whether or not the OK key has been pressed (S113: YES) on the touch panel 9c. The control circuit 61 terminates the display control program step S15D after judging that the OK key has been pressed. The control circuit 61 returns the process flow back to step S109 after judging that the OK key has not been pressed (step S113: NO).

Referring next to FIG. 20, a description will be given in detail on a cut process step S17B. The control circuit 61 begins the cut process step S17B with step S121 indicated in FIG. 20.

At step S121 the control circuit 61 determines whether or not the holding sheet 10 has been set. The control circuit 61 proceeds to step S123 after judging that the holding sheet 10 has been set (S121: YES). The control circuit 61 repeats step S121 after judging that the holding sheet 10 has not been set (S121: NO).

At step S123, the control circuit 61 judges whether or not the cut key has been pressed. More specifically, the control circuit 61 judges that the cut key has been pressed when the touch panel 9c has detected that the cut has been pressed. The control circuit 61 proceeds to step S125 after judging that the cut key has been pressed (S123: YES). The control circuit 61 repeats step S123 after judging that the cut key has not been pressed (S123: NO).

At step S125, the control unit 61 controls the movement of the transfer unit 20 so that the part selected at step S91 is cut. More specifically, the control circuit 61 reads the cut data 720 from the RAM 63 and controls the drive of the transfer unit 20 so that the blade tip 6a is moved along the coordinates defined in the cut data 720.

Then, at step S127, the control circuit 61 judges whether there any other parts to be cut. The control circuit 61 returns the process flow back to step S91 of FIG. 16 when detecting that a "next part" key has been pressed (S127: YES). The control circuit 61 terminates the cut process 17B after detecting that an "END" key has been pressed on the touch panel 9c (S127: NO).

The control circuit 61 terminates the cut control program 500 after terminating the cut process S17B.

#### Effects of the Fourth Embodiment

At step S97, the display 9a displays the parts on the design read by the scanner 60. At step S107, the display 9a displays the combination of parts after changing the design of the locations specified by the user to the designs of the parts. Thus, it is possible to facilitate the user in coordinating the design of the parts.

#### Modified Embodiments

The present disclosure is not limited to the embodiment described above but may be implemented in various other embodiments within the spirit of the disclosure.

At step S25, the scanner 60 is configured to read the image of the entire surface of the workpiece 101 placed on the holding sheet 10 and at step S27, the control circuit 61 is configured to calculate the RGB value based on the image of

the entire surface of the workpiece **101**. Alternatively, the scanner **60** may be configured to read a part of the image of the surface of the workpiece **101** placed on the holding sheet **10** when calculating the colors. For example, the scanner **60** may be configured to read a predetermined number of lines, such as 10 lines, on the image. The control circuit **61** may be configured to calculate the average of the RGB values from the pixels of image of the predetermined number of lines. It is thus, possible to reduce the duration of the process for calculating the color of the workpiece **101**.

In the above described embodiments, the workpiece **101** was attached to the entire surface of the area of the holding sheet **10** being read by the scanner **60**. However, the workpiece **101** may be attached to only a portion of the area of the workpiece being read by the scanner **60**. In such case, the scanner **60** may read the entire surface of the area read by the holding sheet **10**. Then, the control circuit **61** may calculate the outline of the workpiece **101** by executing a known outline extraction process for extracting outlines from the read image. The control circuit **61** may thereafter calculate the average RGB value of the inner region of the outline of the workpiece **101** as the RGB value of the workpiece **101**.

At step **S77**, the control circuit **61** is configured to calculate the square sum of the difference of the RGB values calculated at step **S75** ( $D_i = (R_i - R)^2 + (G_i - G)^2 + (B_i - B)^2$ ), and extract the part that has the smallest square sum  $D_i$  as the most closely approximating color. Alternatively, the control circuit **61** may be configured to extract the most closely approximating color by using HSV values and Lab values instead of RGB values. For example, the control circuit **61** may be configured to calculate the HSV value using known calculation methods as disclosed in JP 2014-50632 A.

HSV stands for Hue, Saturation, and Value. Hue **H** indicates the type of color such as red, purple, and blue, and is represented by a numerical range of 0 to 360 for example. Saturation **S** indicates the vividness of the color and is represented by a numerical range of 0.0 to 1.0 for example. Value **V** indicates the brightness of the color and is represented by a numerical range of 0.0 to 1.0 for example.

A description will be given in detail on how the color most closely approximating the color read by the scanner **60** may be extracted. The control circuit **61** calculates the color phase **H** based on the RGB value read by the scanner **60**. The control circuit **61** calculates the color phase  $H_i$  from the RGB value of the  $i$ th part. Then, the control circuit **61** calculates difference  $H_m = \text{color phase } H_i - \text{color phase } H$ . The control circuit **61** may be configured to calculate difference  $H_m$  in a similar manner for other parts. The control circuit **61** may extract the color most closely approximating the color read by the scanner **60** by extracting the part having the smallest difference  $H_m$ .

Further, the control circuit **61** may be configured to calculate the Lab value based on a known calculation method as disclosed in the method of JP H11-57262 A. The Lab value is based on the Lab color space specified by CIE (Commission internationale de l'éclairage)

A description will be given in detail on how the color most closely approximating the color read by the scanner **60** is extracted using the Lab color space. The control circuit **61** calculates the Lab color space based on the RGB values read by the scanner **60** using a known calculation method. The control circuit **61** calculates the color space  $L_i a_i b_i$  based on the RGB value of the  $i$ th part. Then, the control circuit **61** calculates  $\text{distance} = (L_i - L)^2 + (a_i - a)^2 + (b_i - b)^2$  in the Lab color space.

The control circuit **61** may be configured to calculate the distance in a similar manner for other parts. The control circuit **61** may extract the color most closely approximating the color read by the scanner **60** by extracting the part having the smallest distance.

The transfer unit **20** is configured to cut the workpiece **101** into a desired shape by transferring the cutting blade **6** in the X direction by the transfer mechanism **8** and transferring the workpiece **101** in the Y direction by the feed mechanism **7**. Alternatively, the transfer unit may be configured to cut the workpiece **101** by moving the cutting blade **6** in two directions, namely the X- and the Y-directions without moving the workpiece **101**.

The control circuit **61** is capable of changing the color of the design of a part by reading the color or the design of the workpiece **101** with the scanner **60**. However, the control circuit **61** may be configured to read the color or the design of the workpiece **101** using a camera as is the case in the patent JP H01-250465 A.

The display control programs **S15A**, **S15B**, **S15C**, and **S15D** may be stored in a computer readable storing medium such as a hard disk, a flexible disc, a CD-ROM, a DVD or the like. In such case, the computer readable storing medium may be read and executed through a computer such a personal computer. Further, the display control programs **S15A**, **S15B**, **S15C**, and **S15D** may be a transmission medium which is capable of being distributed over a network such as the internet.

The cutting apparatus **1** is one example of a cutting apparatus.

The cutting apparatus **1** is one example of a display control device.

The cut control program **500** is one example of a cut control program.

The ROM **62** is one example of a storing unit.

The pattern data **600** is one example of a pattern.

The scanner **60** is one example of an acquiring unit.

Steps **S29**, **S65**, **S79**, and **S106** are examples of a changing process.

Steps **S29**, **S65**, **S79**, and **S106** are examples of a change processing unit.

Steps **S25**, **S53**, **S73**, and **S95** are examples of an acquisition control process.

Steps **S25**, **S53**, **S73**, and **S95** are examples of an acquisition control unit.

Step **S31**, **S66**, **S80**, and **S107** are examples of a display control process.

The control circuit **61** configured to execute step **S31**, **S66**, **S80**, and **S107** is one example of a display control unit. Display **9a** is one example of a display unit.

Step **S23** is one example of a first accepting process.

The control circuit **61** configured to execute step **S23** is one example of a first accepting unit.

Step **S63** is one example of a second accepting process.

The control circuit **61** configured to execute step **S63** is one example of a second accepting unit.

Step **S101** or step **S103** is one example of a third accepting process.

The control circuit **61** configured to execute step **S101** or step **S103** is one example of a third accepting unit.

Step **S77** is one example of an extraction process.

The control circuit **61** configured to execute step **S77** is one example of an extraction unit.

Step **S47** is one example of a transfer process.

The transfer unit **20** is one example of a transfer unit.

The control circuit **61** configured to execute steps **S15A**, **S15B**, **S15C**, and **S15D** are examples of a display control program.

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In the embodiments described above, a single CPU may perform all of the processes. Nevertheless, the disclosure may not be limited to the specific embodiment thereof, and a plurality of CPUs, a special application specific integrated circuit (“ASIC”), or a combination of a CPU and an ASIC 5 may be used to perform the processes.

The foregoing description and drawings are merely illustrative of the principles of the disclosure and are not to be construed in a limited sense. Various changes and modifications will become apparent to those of ordinary skill in the art. All such changes and modifications are seen to fall within the scope of the disclosure as defined by the appended claims.

We claim:

1. A cutting apparatus comprising:  
an acquiring unit configured to optically read a color or a design on a surface of at least one workpiece;  
a storing unit configured to store data of a pattern having plural parts of different colors or designs;  
a changing unit configured to change a color or a design of at least one part of a pattern in the data stored in the storing unit to the color or the design optically read by the acquiring unit for the at least one workpiece; and  
a display unit configured to display the pattern having the at least one part in which the color or the design has been changed by the changing unit to the color or the design of the at least one workpiece.
2. The cutting apparatus according to claim 1, further comprising a first accepting unit configured to accept selection of one part from plural parts of a pattern, and wherein a color or a design of the one part accepted by the first accepting unit is changed by the changing unit to the color or the design optically read by the acquiring unit for the at least one workpiece.
3. The cutting apparatus according to claim 1, further comprising a second accepting unit, wherein when colors or designs of plural workpieces have been optically read by the acquiring unit, the second accepting unit is configured to accept selection of one color or one design from the colors or the designs optically read by the acquiring unit for the plural workpieces, and wherein a color or a design of at least one part of a pattern in the data stored in the storing unit is changed by the changing unit to the one color or the one design accepted by the second accepting unit.
4. The cutting apparatus according to claim 3, wherein the colors or the designs optically read for the plural workpieces are displayed so as to be located one next to another on the display unit.
5. The cutting apparatus according to claim 1, further comprising an extracting unit configured to extract, from plural parts of a pattern in the data stored in the storing unit, a part having a color most closely approximating the color optically read by the acquiring unit for the at least one workpiece, and wherein a color of the part extracted by the extracting unit is changed by the changing unit to the color optically read by the acquiring unit for the at least one workpiece.
6. The cutting apparatus according to claim 1, further comprising a third accepting unit that, when the design of the at least one workpiece has been optically read by the acquiring unit, is configured to accept specification of a location on the at least one workpiece optically read, and

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wherein the design of the at least one part of the pattern in the data stored in the storing unit is changed by the changing unit to the design of the at least one workpiece encompassed in the location specified.

7. The cutting apparatus according to claim 1, wherein the acquiring unit comprises a scanner.

8. The cutting apparatus according to claim 1, further comprising cutting blade and a transfer unit, wherein the transfer unit is configured to transfer the cutting blade and the workpiece relative to one another so that the cutting blade cuts each part of a pattern from the workpiece.

9. The cutting apparatus according to claim 1, wherein the pattern having the at least one part in which the color or the design has been changed and plural parts constituting the pattern including the at least one part in which the color of the design has been changed are displayed on the same screen invoked on the display unit.

10. A non-transitory computer readable storing medium, storing computer readable instructions that instruct a cutting apparatus provided with a storing unit and a display unit to:  
optically read a color or a design on a surface of at least one workpiece;

change a color or a design of at least one part of a pattern in data stored in the storing unit to the color or the design optically read for the at least one workpiece; and display a pattern having the at least one part in which the color or the design has been changed to the color or the design of the at least one workpiece on the display unit.

11. The medium according to claim 10, wherein the instructions further instruct the cutting apparatus to accept selection of one part from plural parts of a pattern, and wherein a color or a design of the one part accepted is changed to the color or the design optically read for the at least one workpiece.

12. The medium according to claim 10, wherein the instructions further instruct the cutting apparatus to, when colors or designs of plural workpieces have been optically read, accept selection of one color or one design from the colors or the designs optically read for the plural workpieces, and

wherein a color or a design of at least one part of a pattern in the data stored in the storing unit is changed to the one color or the one design accepted.

13. The medium according to claim 11, wherein the instructions further instruct the cutting apparatus to, when colors or designs of plural workpieces have been optically read, display the colors or the designs optically read for the plural workpieces so as to be located one next to another on the display unit.

14. The medium according to claim 10, wherein the instructions further instruct the cutting apparatus to extract, from plural parts of a pattern in the data stored in the storing unit, a part having a color most closely approximating the color optically read for the at least one workpiece, and wherein a color of the part extracted is changed to the color optically read for the at least one workpiece.

15. The medium according to claim 10, wherein the instructions further instruct the cutting apparatus to, when the design of the at least one workpiece has been optically read, accept specification of a location on the at least one workpiece optically read, and

wherein the design of the at least one part of the pattern in the data stored in the storing unit is changed to the design of the at least one workpiece encompassed in the location specified.

16. The medium according to claim 10, wherein the color or the design of the at least one workpiece is optically read by a scanner.

17. The medium according to claim 10, wherein the cutting apparatus is further provided with a cutting blade and a transfer unit, wherein the instructions further instruct the cutting apparatus to operate the transfer unit to transfer the cutting blade and the workpiece relative to one another so that the cutting blade cuts each part of a pattern from the workpiece.

18. The medium according to claim 10, wherein the pattern having the at least one part in which the color or the design has been changed and plural parts constituting the pattern including the at least one part in which the color of the design has been changed are displayed on the same screen invoked on the display unit.

19. A display control device comprising:

an acquiring controller configured to cause an acquiring unit to optically read a color or design on a surface of at least one workpiece;

a changing unit configured to change a color or a design of plural parts of a pattern in data stored in a storing unit to the color or the design of the at least one workpiece caused to be optically read by the acquiring unit by the acquiring controller; and

a display controller configured to display the pattern having plural parts in which the color or the design has been changed to the color or design of the at least one workpiece on the display unit.

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